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GENERAL SCIENCE QUARTERLY

... CONTENTS ...

	PAGE
Editorials	523
A Study of Achievement and Subject Matter in General Science. <i>August Dvorak</i>	525
A Half Century in Chemical Education. <i>J. N. Taylor.</i>	543
Turnynge. <i>Edna Hook Lissak</i>	557
Science Education in China. <i>Walter G. Whitman..</i>	562
A Fireless Cooker Project. <i>Harvey H. Goodwin....</i>	568
Projects in Physics. <i>Burgoyne L. Griffiths</i>	572
Earthquakes. <i>Wilbur Garland Foye</i>	577
Available Motion Picture Films	581
Summer Courses in Science	586
The New Books	588
Science Articles in Current Periodicals	590
Magazine List	596

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NUMBER 4

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This successful book is now presented in new form. It retains all the distinctive features that were originally responsible for its success, and has added many new ones which make a good book better. In order to meet changes in curriculum necessitated by recent progress in science, SCIENCE OF HOME AND COMMUNITY has added the following new features:

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Vol. X

MAY, 1926

No. 4

❁ EDITORIAL ❁

We, editorially speaking, like editorials. That is, we like to write them, and usually we like to read them. The General Science Quarterly has not printed editorials for some time. Because we are only temporarily editing this magazine, we have thought that perhaps we ought not to depart from custom. However, having a few comments to make we thought we would print them editorially in this issue. as it will very likely be our last chance. It is expected that Professor Whitman will return from China, where he is now teaching, next fall.

—o—
In speaking of Professor Whitman, it reminds us that he has been kind enough to write an article for us on the science education situation in China, which is printed in this issue.

—o—
We often have requests for science plays, yet we seldom have one sent to us for publication. If you have worked out any sort of dramatization in connection with your general science teaching, will you not send us an account of it, so that we may make your experience of benefit to other teachers.

In an address by Professor Millikan, printed in "School and Society," November 21, 1925, and in "School Science and Mathematics," December, 1925, he makes some statements that would make many science teachers wish to sit down immediately and pen a reply. Professor Eliot Downing has so ably done this in the January 16, 1926, issue of "School and Society," that we call attention to it rather than attempt a reply of our own, which could not be nearly as good.

—o—
One of the most effective means of contact between science and the pupil's interest is through the historical method of approach. We have evidences of this through the method of presentation of some of the science units as given in the newer texts; for example, the evolution of the methods of getting water, from the old spring house, through well sweeps, pulleys and windlasses, to the pump; or the evolution of communication from the beginnings of speech through the invention of the alphabet, smoke signals, heliograph, telegraph, telephone and radio. Material of

interest for use in developing a topic by this method is furnished in an article on the evolution of the lathe, "Turning," which appears in this issue.

—o—
In a letter recently received were the two questions which follow:—

Question A

"If I put an iron stove-lid over a blue-jet gas flame of a gas stove, will it warm air in the room any quicker or better than same gas flame naked would do, and why?"

Question B

"There is a classical question as to where goes the energy used in winding a watch-spring, fastening it so it will not unwind, and then putting it in an acid solution, so it will dissolve without unwinding. Has this experiment been actually performed?"

Is there material here with which to start a class discussion?

—o—
Duane E. Roller, Department of Physics, University of Oklahoma, Norman, Okla., 1925, has prepared a booklet, "Sources of Free Material for Use in the Teaching of Natural Science," 35 pages, which will be sent free to those interested in the teaching of natural science in secondary schools.

This bulletin contains a comprehensive list of charts, exhibits, literature, slides and films, which may be obtained free of charge from industrial concerns and educational agencies. It describes briefly each piece of material and classifies it with respect to its suitability for physics, chemistry, the biological sciences, and general science. In compiling this bulletin, inquiries for free material were sent to over four hundred firms and societies, while more than twelve hundred pieces of material were received and examined.

The Department of Physics, University of Oklahoma, has available for free distribution some thirty other monographs and bulletins for science teachers. A list of these publications is sent free to teachers upon request.

—o—
CORRECTIONS

The book review which appeared in the March issue as "Introduction to Fiske Science," should have read, "Introduction to Physical Science."

The playlet, "A Trip Through Sky," printed in the same issue, was by Miss Mildred E. Reeve, of the *Hathaway-Brown* School, Cleveland, Ohio.



A Study of Achievement and Subject Matter in General Science

By AUGUST DVORAK,

School of Education, University of Washington.

(Concluded)

In order to ascertain to what extent other sciences contributed towards the achievement of pupils who had not had General Science, the number of sciences which the pupils had taken were counted for 5,970 cases. Table VIII (*Number of Sciences per Student for 5742 cases*) gives the distribution of the pupils in the twenty grade groups and the number of the sciences, which these pupils had listed on the first page of the original test in General Science, completed by each pupil. At the right of the Table in the column headed "TOTAL" is the actual number of sciences, each taken for one year, or "science years," which were taken by the group listed at the left. Thus 582 is the sum of 49 times zero plus 206 times 1 plus 176 times 2 plus 8 times 3, or the total number of times any sciences were taken by all of the 439 girls. Likewise, 233 is the sum of 163 times 0 plus 186 times 1 plus 22 times 2 plus 1 times 3, or the total number of times any sciences were taken by all of the 372 — 8 Boys. On the basis of Table VIII, Table IX was computed. It gives the mean number of sciences per pupil in each of the different grade groups.

TABLE VIII

Number of Sciences per Student for 5742 Cases

<i>Student Groups</i>	<i>No. Students</i>	<i>0</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>Total</i>
<i>No. of Students having the above No. of Sciences</i>												
—8 Girls	439	49	206	176	8	..	..	..	..	..	..	582
—8 Boys	372	163	186	22	1	..	..	..	..	..	..	233
+8 Girls	44	..	8	10	25	1	..	..	..	..	..	107
+8 Boys	49	..	9	36	4	..	..	..	..	..	..	93
Total	904	212	410	243	38	1	..	..	..	..	..	1015
—9 Girls	482	89	220	138	22	6	6	1	..	..	..	622
—9 Boys	300	188	71	32	3	5	1	..	..	..	..	169
+9 Girls	351	..	57	131	145	10	3	5	..	..	..	839
+9 Boys	294	..	150	127	16	1	..	..	..	..	..	456
Total	1427	277	498	428	186	22	10	6	..	..	..	2086
—10 Girls	513	116	181	147	42	13	12	2	..	..	..	725
—10 Boys	289	100	105	58	14	7	5	..	..	..	..	316
+10 Girls	261	..	23	103	93	23	9	6	4	..	..	709
+10 Boys	242	..	80	86	54	13	5	8	..	..	..	509
Total	1305	216	389	394	203	56	31	16	4	..	..	2259
—11 Girls	440	32	91	127	114	50	16	9	1	..	..	1028
—11 Boys	263	38	69	88	46	15	6	1	..	..	..	479
+11 Girls	197	..	23	33	61	44	23	11	2	..	..	643
+11 Boys	143	..	16	47	49	18	5	5	3	..	..	405
Total	1043	70	199	295	270	127	50	26	6	..	..	2555
—12 Girls	347	17	46	76	104	53	25	14	11	1	..	1016
—12 Boys	210	5	25	61	68	30	13	5	2	1	..	588
+12 Girls	192	..	3	21	44	59	33	13	14	2	3	797
+12 Boys	141	..	3	16	43	45	17	9	6	2	..	541
Total	890	22	77	174	259	187	88	41	33	6	3	2942
Univ. I	9	..	1	1	4	2	..	1	..	..	..	29
" II	134	..	..	17	43	38	23	9	3	1	..	513
" III	18	..	..	2	7	1	4	2	1	1	..	76
" IV	6	..	..	..	..	1	5	..	..	..	..	29
Total	173	..	1	20	58	44	32	12	4	2	..	667

TABLE IX

Mean Number Sciences per Pupil in the Various Grades and per University Student in Four Groups

Group	Grades: 8th	9th	10th	11th	12th
—Girls	1.32	1.39	1.41	2.34	2.92
+Girls	2.43	2.38	2.72	3.27	4.16
—Boys	.63	.56	1.10	1.82	2.80
+Boys	1.90	1.55	2.10	2.83	3.84

University (I) 3.22 (II) 3.82 (III) 4.22 (IV) 4.83

Thus 582 (Table VIII) divided by 439 equals 1.32 or the mean number of sciences per pupil in the —8 Girls' group. Likewise, 233 (Table VIII) divided by 372 gives .63 or the mean number of sciences per pupil in the —8 Boys' group.

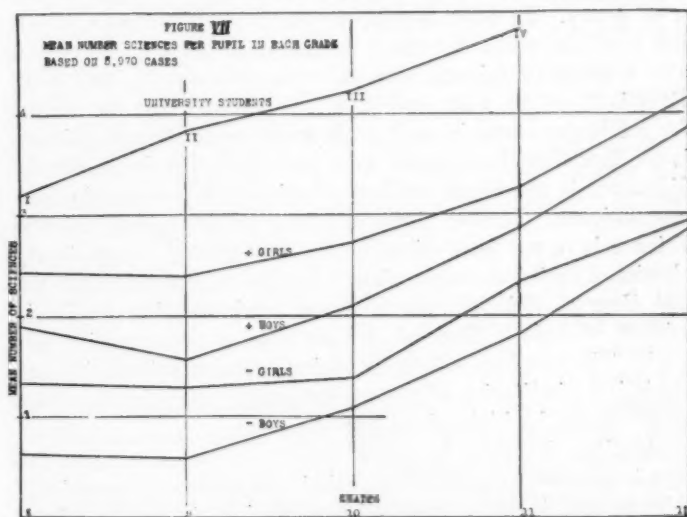


Figure VII (*Mean Number Sciences per Pupil in Each Grade Based on 5,970 Cases*) is a graphic representation of Table IX. It is worth while to notice that girls uniformly are credited with a higher mean number of sciences than are boys of similar classification. That is, girls without General Science have a higher mean number of sciences per pupil than boys without General Science in the same grade, and girls with General Science have a higher mean number of sciences

per pupil than boys with General Science in the same grade. This would seem to indicate a fallacy in the commonly accepted theory that girls take fewer sciences than do boys. It would also give a clue as to the reason for the growth in General Science achievement as indicated by the median scores on the test for each grade. That is, —12 Girls are only 12 points lower than the +12 Girls because the —12 Girls have taken practically three sciences (2.92) by the end of their twelfth year. The duplication and overlapping of the courses themselves have practically made up the handicap of not having had General Science in the 8th or 9th grade.

It is also worth while to notice that when either the — and + Girls or — and + Boys are considered, the mean number or sciences in each grade for the "+" group is simply greater by one than is the mean number of sciences of the "—" group. In other words, the number of sciences for —8 Girls is 1.32 while for the +8 Girls it is 2.43, 1.11 greater. The number of sciences for the —9, —10, —11, and —12 Boys is .56, 1.10, 1.82, and 3.84. This shows that one reason for the larger scores in each grade group with General Science, is the fact that *those pupils have had General Science*, for the difference in the mean numbers of sciences is 1—namely General Science. It also shows that the pupils taking General Science have not been stimulated to any greater extent in the election of science courses than have the pupils who have not had General Science. As a means of interesting pupils in science, therefore, General Science does not necessarily succeed. The numbers of pupils taking 0 and 1 science in each grade is an indication of the current apathy for science courses on the part of a high school population.

It might, however, be worth while to notice a possible fallacy in the above statement may lie in the matter of "required" sciences and in the current science offerings in the 22 schools studied. That is, many schools require one or more sciences unless the pupil satisfies some other conditions which relieve him from taking science courses. If one or two sciences were required, of which one might be General Science, then the mean number of sciences per pupil, being larger for pupils having taken General Science, would indicate that General Science did have some drawing power for further science courses, inasmuch as the pupil need not have taken extra science courses,

after having satisfied the science requirements—but which many proceed to do as indicated by the means. Furthermore, few schools offer more than three science courses; many offer only two. Glancing at Table VIII, it is evident that with the exception of the 8th and 9th grades, where pupils have not had time to take more than three sciences, the columns of 2 and 3 sciences maintain the largest percentage of pupils.

A brief study of the achievement of 150 seniors, all of whom had had five or more sciences, showed that in achievement on the General Science test they scored as follows.

<i>Scores</i>	<i>No. Cases</i>
150-159.....	4
160-169.....	14
170-179.....	22
180-189.....	24
190-199.....	25
200-209.....	22
210-219.....	17
220-229.....	16
230-239.....	7
240-249.....	5
250-300.....	4

Total...150

It is to be remembered that score 175 is in the 50 percentile for the achievement of +12 Girls. One hundred twenty-one or 80% of these seniors with five sciences were in the upper half of the distribution of +12 Girls. This would seem to indicate that the more sciences students took the more proficient they become in this test.

Reference to the relatively larger number of sciences per pupil on the part of the girls and their relatively lower achievement on the test as compared with boys, prompted an analysis of the actual sciences taken by different groups of pupils. Table X (*Frequencies with which different Sciences*

TABLE X

*Frequencies with Which Different Sciences were Taken by
5742 Students*

<i>Student Groups</i>	<i>No. Cases</i>	<i>Gen. Science</i>	<i>Chemistry</i>	<i>Physics</i>	<i>Physiology</i>	<i>Botany</i>	<i>Zoology</i>	<i>Phystrgraphy</i>	<i>Biology</i>	<i>Astronomy</i>	<i>Domes. Sci.</i>	<i>Total</i>	<i>Frequency</i>
-8 Girls	439	..	..	..	251	1	..	2	8	1	319	582
-8 Boys	372	..	..	..	211	..	..	2	..	..	20	233
+8 Girls	44	44	..	..	35	1	..	..	..	..	27	107
+8 Boys	49	49	..	..	36	..	..	1	4	1	3	93
Total	904	93	..	..	533	2	..	5	12	2	369	1015
-9 Girls	482	..	..	..	192	13	12	11	69	3	322	622
-9 Boys	300	..	..	..	84	13	8	17	43	1	3	169
+9 Girls	351	351	..	..	193	12	6	4	12	4	257	839
+9 Boys	294	294	..	..	124	..	3	5	13	2	15	456
Total	1427	645	..	..	593	38	29	37	137	10	597	2086
-10 Girls	513	..	..	2	239	40	25	30	109	3	277	725
-10 Boys	289	..	2	1	146	25	15	40	71	1	15	316	
+10 Girls	261	261	2	..	120	18	16	35	59	1	197	709	
+10 Boys	242	242	6	1	96	19	13	51	56	..	25	509	
Total	1305	503	10	4	601	102	69	156	295	5	514	2259	
-11 Girls	440	..	88	70	260	86	53	64	130	2	275	1023	
-11 Boys	263	..	65	93	127	39	19	44	82	3	8	479	
+11 Girls	197	197	31	36	83	42	23	34	56	4	137	643	
+11 Boys	143	143	22	66	65	25	18	26	35	..	5	405	
Total	1043	340	206	265	535	192	113	168	303	8	425	2555	
-12 Girls	347	..	135	134	207	80	49	70	96	2	243	1016	
-12 Boys	210	..	121	160	130	28	19	59	62	1	8	588	
+12 Girls	192	192	75	88	114	55	20	47	57	1	148	797	
+12 Boys	141	141	71	93	89	35	19	44	33	1	15	541	
Total	890	333	402	475	540	198	107	220	248	5	414	2942	
Univ. I.	9	5	6	8	3	2	3	2	..	..	..	29
" II	134	31	131	133	101	31	21	29	21	11	4	513	
" III	18	3	18	18	13	4	9	3	6	2	..	76	
" IV	6	1	6	6	6	4	2	2	1	..	1	29	
Total	173	43	161	169	128	42	35	38	28	13	10	667	

were Taken by 5742 Students) which shows the frequencies with which different sciences were taken by 5,742 pupils in the five grades, leads one to conclude that the higher mean number of sciences per pupil, for instance of the +9 Girls over the +9 Boys, is due to the fact that relatively larger numbers of girls take Physiology than do boys, and that a high percentage of girls take Domestic Science, which is seldom taken by boys. Inasmuch as the difference in the mean number of sciences per pupil at any grade is comparatively small (about $\frac{1}{2}$ a science per pupil in favor of the girls), when either —Girls or —Boys or +Girls and +Boys are considered, this latter explanation seems quite feasible. There is a relatively small number of items in the test which would be answered by Domestic Science training. This may partially account for lower scores by girls in the same grade than by boys, even though the girls have more science courses to their credit.

D. DIFFERENCES IN ACHIEVEMENT DUE TO INITIAL POSSESSION.

In ordinary practice the teacher of General Science, like the teacher of many other secondary school subjects, frequently meets his or her class for the first time on the opening day of school. The teacher's assignment is to meet that class during the following nine months, and to teach it as much General Science as he or she is capable of teaching the class or as the class is capable of being taught. At the end of every month and at the end of each quarter, semester, or year, this teacher has to assign ratings to each pupil, which ratings are to indicate the amount of accumulated information and knowledge which in the teacher's opinion the pupil has achieved in General Science. Frequently the teacher knows nothing of the abilities of the various members of the class. The class may be composed of individuals with various levels of so-called "native ability" or "intelligence," which is known to have an important function in the speed and amount of learning of which the pupil is capable. Irrespective of this, at the end of the year or at the end of each quarter or semester, the rating assigned by the teacher on General Science is supposed to be indicative of the amount the pupil has profited by instruction, regardless of his ability to learn.

In a better organized present-day school the class to which the teacher is assigned may have been selected on the basis of mental tests and may therefore have comparative homogeneity of ability. Modern technique has triumphed and the teacher sets forth to do the best he or she can with the class. Results have shown that a homogeneous class selected on the basis of intelligence tests is capable of more efficient progress on the part of all its members than a heterogeneous class. Few administrators have gone beyond this new step in modern educational administration. A few of the more daring investigators have attempted to secure ratings on the achievement tests for pupils before they have begun their study of the subject. Similar ratings at the close of a year's study of the subject have shown that not all of the pupil's usual rating in a subject at the end of a quarter, semester, or year is due to his study of the subject. In other words, it has been suggested that *the pupil's final achievement in a subject may be conditioned by his starting point*. Pupils entering on their study of General Science enter the class, not only with differences in mental abilities but also with various amounts of the subject matter of General Science already in their possession. What teacher of General Science has not been amazed at the apparent ease with which many 8th and 9th grade boys, during the radio craze, talked of "tuning coils," "condensers," "'B' batteries," "wave lengths," "peanut tubes," "variometers," and so forth—subject matter and vocabulary which ten years ago was common only to the advanced student of Physics. It is easy to imagine the disdain with which these boys would listen to a dissertation by a not overly expert teacher on a simple subject such as "a fuse" or "a magnetic coil" or a "knife switch"—subject matter and vocabulary which to certain other members of the class seem most complex because of the previous lack of information on the part of these other members.

A study of the 8th grade scores made on the General Science test by boys and girls who had not had General Science and of the scores of 11th and 12th grade pupils many of whom had had several specialized sciences, shows considerable overlapping. Reference to Figure IV(e) shows that 25% of the —8 Boys do as well as 3 to 5% of the 12th grade boys who have had a mean number of 3.84 sciences per pupil, including General Science. Twenty-five percent of the —8 Girls do

as well as 8 to 10% of the 12th grade girls who have had a mean of 4.16 sciences per pupil, including General Science. The fact is also apparent that only 5% of the 12th grade pupils in either group exceed the scores made by the best 8th grade pupils who have not had General Science. Likewise only about 25% of the 8th grade pupils who have not had General Science do poorer work on the General Science test than the poorest 12th grade pupil. It is easy to understand some of the class problems if in that class are to be found several boys or girls who belong to the upper level of the 8th grade group just described. It is also possible to realize how little some of the better pupils are really able to achieve in a class of this kind when the subject matter of that course is already largely in their possession.

In accordance with the findings of this study, it is the writer's purpose to suggest that pupils be divided for the purpose of class instruction on the basis of the amount of the subject matter of General Science already in their possession rather than on just mental ability. Of course the ideal condition—the most commendable class room situation in a school large enough to permit it—would be that pupils for the sake of homogeneity in teaching be divided on the basis of initial amount of subject matter already in their possession and also on their ability further to acquire subject matter. This suggestion is further strengthened by reference to Figure IV(e), which shows that the fifty percentile of the —8 Girls exceeds the seventeen percentile of the +8 Girls and the nine percentile of the +9 Girls in achievement. Likewise the ninety percentile of the —8 Girls exceeds the sixty-seven percentile of the +8 Girls and the forty percentile of the +9 Girls in achievement. It must be borne in mind that whatever the amount of percent of —8 Girls that exceed or even equal achievement of +8 or +9 Girls, this amount or percent tends to represent the amount of effort wasted in their teaching, unless some adaptation is made to suit the differences in subject matter already mastered.

It may also be added that the General Science test given before pupils have begun the study of a subject, gave a correlation of .62 between test scores and school marks for the first two quarters. This would seem to indicate that the amount that pupils know of a subject before studying it, is

an important factor in conditioning the achievement which they will receive in that subject when they study it, if the school marks are any measure of achievement.

Reference to Figure IV or to Table VII shows that whereas the median for —8 Boys was 127 and the median for —8 Girls was 114 or 13 points less, and that the median for +9 Boys was 162 and for the +9 Girls was 150 or 12 points less. That is, initially the boys exceeded the girls by 13 points and one year later (on the basis of the 9th grade scores) the boys still exceeded the girls by 12 points or practically the same amount by which they had exceeded the girls before instruction. In the 10th year the medians were 157 for the +Girls and 168 for the +Boys, or 11 points better. In the 11th year the median score for plus girls was 158 and for plus boys 188, or 30 points better. Reference to the mean number of sciences per pupil shows that between the 10th and the 11th years the increase in the mean number of sciences per pupil is greater by about one-fifth science for the boys. Reference to Table X shows that 88 of the +11 Boys or 61% had taken Physics or Chemistry (Chem. 22: Physics 66), while only 67 (Chem. 31: Physics 36) or 34% of the +11 girls had added these so-called "harder" sciences to their possession. In the 12th year, when each group had added practically a whole science to its mean, the median for the +12 Girls was 175 while for the +12 Boys the median was 190, a difference of 15 points. Throughout this comparison it is evident that differences in grade medians, after the subject was studied, are dependent to a large extent on differences of grade medians before the study of the subject was begun.

E. COMPARISON OF 8TH AND 9TH GRADE ACHIEVEMENT.

It is possible to compare the achievement on the 221 item and on the 300 item test for 100 pupils (50 boys and 50 girls) who took General Science in the 8th grade of the Junior High School. These data may be significant.

221 ITEM TEST.

Median Scores of:		—8 Group	+8 Group	—9 Group	+ Group
Girls	.....	84	95	90	111
Boys	.....	92	111	98	116

300 ITEM TEST.

Median Scores of:		—8 Group	+8 Group	—9 Group	+ Group
Girls	.....	114	131	126	150
Boys	.....	127	155	135	162

It is significant to note that the +8 Girls do better in the test than either the —8 Girls or —9 Girls but not so well as the +9 Girls, and that the +8 Boys do better than the —8 Boys and the —9 Boys but not so well as the +9 Boys. When, however, the difference between the —8 and the —9 grade groups (the amount due to growth without General Science) is added to the +8 grade medians [$111+(98-92)=117$ whereas the +9 B Median is 116 (221 item test); $155+(135-127)=163$ whereas the +9 B Median is 162 (300 item test)], for the boys the total is almost identical with the +9 Boys' median, while for the girls it is slightly less than the +9 Girls' median. [$95+(90-84)=101$ whereas the +9G median is 111 (221 item test); $131+(126-114)=143$ whereas the +9G median is 150 (300 item test)]. Inasmuch as +9 pupils owe their score to the sum of their progress without study of General Science plus their progress with study of General Science, it would seem that the 8th grade pupils profited equally as much by instruction in General Science as did the 9th grade pupils. Knowledge of this is especially of value in the construction of a course of study for a Junior High School.

F. SEX DIFFERENCES.

In the tabular and graphic data presented so far it has been evident that a more or less uniform difference exists between the achievement in General Science of boys and girls for the plus and minus groups. This difference in test medians between boys and girls was in favor of the boys, as indicated in the following tabular statement.

The Amounts by Which Boys' Medians Exceed Girls' Medians on 300 Item Distributions

	Grade				
	8th	9th	10th	11th	12th
Plus Group	24	12	11	30	15
Minus Group	13	11	15	22	28

It has previously been demonstrated that the maximum difference of medians on the 300 item distributions, which is necessary just to eliminate all chance possibilities of its not being a difference, is 10.5. It is evident that the above differences all exceed 10.5 and are therefore actual differences. Similarly examination of Table V will show that medians for

the boys' groups exceed medians for the girls' group by an amount greater than 6.1 which is just necessary to eliminate all chance errors of its not being a difference.

G. ANNUAL GROWTH IN ACHIEVEMENT.

The optimistic teacher will probably be astounded by the statement that the amount of achievement, as measured by a Scale, due to a year's work or study in a subject results in relatively smaller gains than even the more conservative teacher would estimate. When the amount of annual growth is computed on the basis of median scores on the General Science test, we find that the differences between -8 Girls and $+9$ Girls and between -8 Boys and $+9$ Boys (the only two places in this study where a comparison of this kind would be safe) are 36 points and 28 points respectively when quartile deviations are 14.5 and 17 for the 8th and 9th grade girls and 19 and $22\frac{1}{2}$ for the 8th and 9th grade boys.

When the difference between -8 th grade pupils and $+9$ th grade pupils is computed on the basis of Scale points or P. E. values based on item difficulty, the difference due to instruction appears even smaller. Reference to Figure I shows that the 8th grade median, which is the average of the medians for the -8 Girls and the -8 Boys, is 7.451 P. E. above the arbitrary zero. The 9th grade median, based on the average of the medians of the $+9$ Girls and the $+9$ Boys, was 8 P. E. above the arbitrary zero. The differences due to one year's growth and teaching was found to be .539 P. E. or about 5.4 Scale points. This difference corresponds fairly closely with differences found by Doctor Van Wagenen who reports that in his studies of History, Geography, and English Composition,* about .6 P. E. or 6 Scale points is the median amount of growth to be expected from one year's teaching.

This may be at least partly explained by assuming that there are hierarchies of ideas or conceptions developed in the learning of any subject material other than mere routine memory work. That is, it is impossible to teach or to understand a complex, difficult idea or conception apart from the basic facts, ideas or conceptions which underlie it. Thus it is impossible really to understand the working principles of a suction pump without first understanding the principle of air

* Unpublished data.

pressure. Nor is it possible to teach or to understand respiration without first teaching or understanding oxidation. The understanding of heredity requires some understanding of reproduction and of cell structure. It is apparent that if one measured the progress made in any course by the number of really complex ideas or conceptions acquired, the progress would necessarily be smaller than if one measured it by the number of illustrations or of the sub-ideas of these complex conceptions. If a scale of complex ideas or conceptions is constructed in such a way that the unit of measurement is an idea or conception which is possessed by 50% of pupils who have studied the subject for one year, the amount of growth will necessarily be small.

It must be borne in mind when comparing Scale and test scores and Scale and test medians that, as is seen in Table II, if pupils are able to do tasks of the difficulty of those found 8 P. E. above the arbitrary zero because of the large number of items in the Scale which are in the range of approximately 1 P. E. above and 1 P. E. below this median of 8 P. E. (See Table II), the pupils' scores have a tendency to show erratically large amounts of growth, as is indicated by the medians in the former paragraph. That is, because as many as 18 items were found to be of the same difficulty, namely 7.9 P. E., it is logical to assume that if a pupil who could do only items of the difficulty of 7.8 P. E. were in some way to acquire ability to do items one-tenth of 1 P. E. more difficult, namely 7.9 P. E., this achievement would be indicated on the original test by an increase of not 1 point but 18 points, whereas on the Scale this added achievement would be indicated by an increase of 1 point. Therefore an increase of .539 P. E. or of 5.4 tasks on the Scale really means the acquisition of a rather large number of conceptions subordinate to these 5.4 tasks.

A word of warning should, however, be given with regard to the comparison of the test medians to measure the amount of growth which is due to instruction in the upper grades. In the study of "overlapping," data were cited which showed that certain numbers of 8th grade pupils without General Science exceeded the achievement of various percents of 9th grade pupils who had studied General Science. It does not require much statistical comprehension to imagine what would happen

to a median if one had a thousand 8th grade pupils with a median of 100 with a range of 50 to 150 and then were to eliminate the lower 50%. The median would immediately rise to the position previously occupied by the 75th percentile. Whereas such an elimination did not take place from the 8th to the 9th grade, for the whole school systems were given the General Science test and no such decrease of pupils was found from the 8th to the 9th grade, nor did the correlations between scores and the time used in doing the test, nor the correlations between scores and chronological age verify the assumption of any such elimination; some elimination, however, did take place in the upper grades.

H. RELATIVE DIFFICULTY OF THE DIFFERENT ITEMS FOR BOYS AND GIRLS.

In Chapter VI under the introduction to the "Derivation of the Scale" were presented data which answer the question, "Do boys and girls differ in the kind of material each is capable of learning and does learn?" The rank orders of the 300 items were made on the basis of the number of correct responses made by 500 —8 Girls and by 430 +9 Girls. The rank order correlation of these rankings gave a coefficient of .87 with a P. E. of .007. The same was done for 400 —8 Boys and 430 +9 Boys, which gave a coefficient of correlation of .916 with a P. E. of .005. The mean of these two coefficients is .893. When the correlation was computed for —8 Girls and —8 Boys, the coefficient was .95 with a P. E. of .003, while for +9 Girls and +9 Boys it was .91 with a P. E. of .005. The mean of the two coefficients is .93.

In other words, the rank orders of the items for the untaught girls and untaught boys were more alike than were the rank orders of the items for girls before and after taking General Science. Likewise the rank orders of the items were more alike for taught 9th grade girls and boys than were the rank orders of the items for the boys before and after taking General Science. The medians of the boys' groups were of course higher than were the medians of the girls' groups, but except for a few items highly specialized for each group, the relative order of difficulty of the items remain practically the same. This would mean that not parts of General Science were more difficult for girls than for boys but that relatively *all* of Gen-

eral Science was as much more difficult for girls than for the boys as is indicated by the difference in the medians. The study of annual growths showed that girls actually make as large gains by instruction as do boys. The difference in the achievements on the General Science test began for the two sexes back in the elementary school and in the elementary training outside of the school, for the difference in medians which is found between girls and boys in the 8th grade is the difference which continues throughout the grades of the secondary school when measured by the General Science test.

CHAPTER IX

SUMMARY.

A summary of the conclusions reached in this study of subject matter and achievement in General Science is given in the following brief statements:

1. General Science originated out of a desire for a course of science which would serve, not necessarily as intensive training for a specialized field, but for immediate use in everyday life.

2. The development of General Science has been paralleled by the formulation of General Science objectives in harmony with the Cardinal Principles of Education.

3. Achievement in General Science can be measured objectively, as is shown by the development of a reliable scale in General Science.

4. A Scale Form of 60 properly evaluated and selected items gives as accurate results in the measurement of General Science achievement as does a 300 item test.

5. Before taking a course in General Science, many pupils are already familiar with much of the material of the course. This fact makes it desirable if not imperative to classify pupils for instruction in General Science on the basis of their previous knowledge of the subject. Furthermore, it emphasizes the need for General Science texts adapted to pupils of different mental levels.

6. The annual increase in achievement in General Science due to teaching, as measured by the General Science Scale, is small, namely, .539 P. E. or 5.39 Scale points.

7. Real sex differences in amount of General Science information exist even prior to instruction in General Science. These sex differences, in favor of the boys, persist throughout the high school course.

8. The relative order of difficulty for the items of the General Science test is practically similar for the two sexes.

9. There is a wide variation of achievement in General Science among different schools.

10. The difference in test points between the median scores of 8th grade pupils who have and who have not had General Science, is equal to the difference between the median scores of 9th grade pupils who have and who have not had General Science. This indicates that 8th grade pupils profit approximately as much by instruction in General Science as do 9th grade pupils.

11. Pupils who have not had a course in General Science acquire considerable General Science information in courses in specialized sciences. *Differences in central tendencies continue, however, in favor of those pupils who have had General Science.*

12. Achievement in the General Science test shows uniformly higher scores for pupils who have had a course in General Science.

13. Performance on the General Science Scale shows for each sex a definite, direct relationship to the number of science courses the pupil has taken.

14. Any two of the five grades studied show considerable overlapping of achievement, even in the case of 8th and 12th grade pupils.

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Candlewax Stains

If colored candlewax stains on clothing are treated promptly they can be removed without great difficulty, says the United States Department of Agriculture. These waxes consist of paraffin in which an organic dye is dissolved. Remove the paraffin as completely as possible by scraping it away, then place a clean blotter on each side of the fabric, over the stain, and pass a warm iron over the spot. The grease is melted and is absorbed by the blotting-paper. Then dissolve the coloring matter remaining in the fiber by sponging it with denatured alcohol. If a slight grease spot still remains, remove it by sponging with one of the cleaning agents, such as chloroform, carbon tetrachloride, ether, gasoline, naphtha, or benzol. The first two are the safest to use, as they are not inflammable. Take the greatest care in using any of the inflammable solvents. It is best to use them in a shady place out of doors; if in the house, by an open window and away from all flames. Sometimes the part of the material having a spot has to be immersed in a bowl containing the cleaning fluid. In general, when this is the case, it is more satisfactory to immerse the whole article finally in fresh cleaning fluid, which prevents the formation of rings.

A Half Century In Chemical Education

A Chronological Record of the Scientific Contributions of
Charles Edward Munroe.

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(Continued from March issue)

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Turnynge*

By EDNA HOOD LISSAK.

THE origin of the turner's art, one of the most used and useful of all arts, is lost in antiquity, and there is no definite knowledge of the inventor of its chief tool, the lathe, nor even of the authentic derivation of its name. It may have been suggested by the fact that the older form of turning-lathe was worked by means of a spring-lath overhead.

The potter's wheel—the earliest lathe—is mentioned in several books of the Old Testament and was familiar to the ancient Greeks. Diodorus Siculus attributes its invention to Talus, a nephew of Daedalus, who is said to have used a lathe about 1240 B. C. Pliny ascribes the honor variously to Phidias and to Theodore of Samos, who lived much earlier. He also mentions one Thericales as famous for his dexterity with the lathe. A proverb of the ancients expresses delicacy and precision in a thing as "formed in the lathe," and their skill in its management is shown by the beauty of the vases which they turned and decorated with figures and ornaments in bas-relief.

In the eleventh century, in France, stone columns and their bases were turned on the lathe, and from the twelfth century the "tour en l'air" was used for turning hollow pieces.

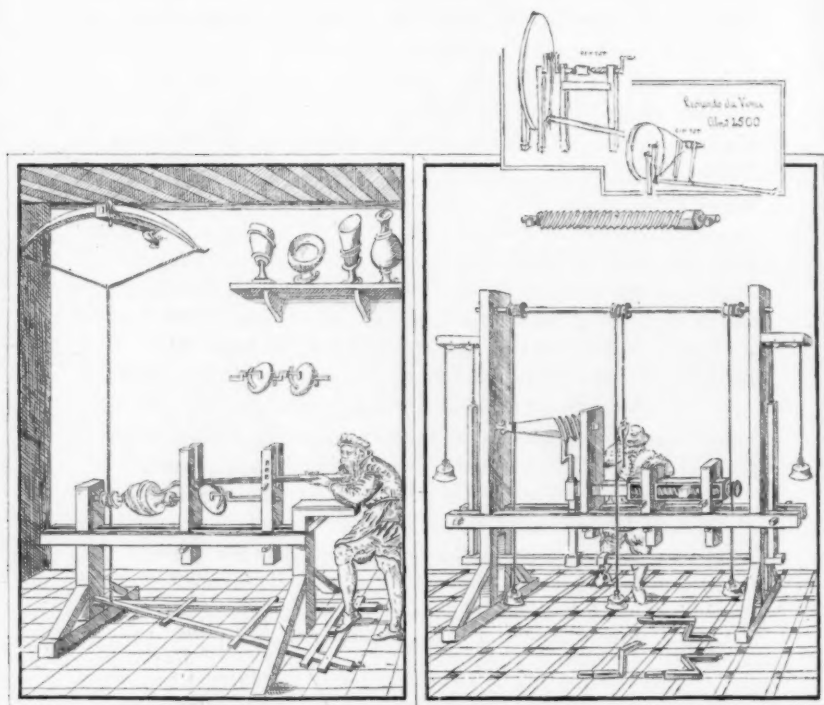
The "Registres de la Taille" of 1292 has names and addresses of thirteen turners established in Paris, and the same register in 1313 mentions ten; in the seventeenth century a guild was formed. Besides being the principal tool of these turners of wood, iron and bronze, who worked exclusively upon it, the lathe was indispensable to many other workers in gold and silver, copper, brass, pewter, marble and stone, and in ivory, tortoise-shell and horn, and it was usually on the lathe that the lapidary, the goldsmith, the watchmaker, the spectacle maker, the potter of pewter, the maker of beads and the cabinet maker began or finished their most beautiful work.

The early lathes turned a simple form, round and uniform, and for a long period little was done to improve them or to simplify their mechanism. But during the Renaissance the

* From "The Edison Monthly," by courtesy of the New York Edison Co.

great interest shown in the "curious art of turning" by the aristocracy of France, led to rapid improvement.

In the sixteenth century the "tour en ovale" was invented, and so marvelous was it considered, that, a hundred years later, it was still the ambition of the most skilled professional to acquire the title of "tourneur en ovale."



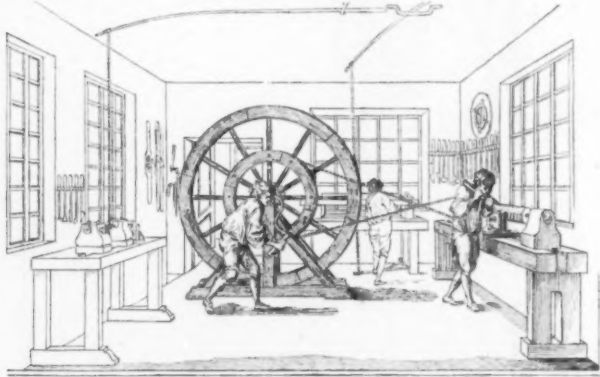
Drawing by Edna Hood Lissak

From the *Trattato di Architettura* of 1578

Jacques Besson's Lathes, as drawn in Francois Beroalde's book on the "Instruments" of Besson, published at Lyons in 1578. The one at the left is a Bow Lathe for turning elliptical and ornamental work. The one at the right is the earliest Screw Lathe known. This curious lathe has its tool traversed alongside the work by means of a guide-screw which is moved simultaneously with the work to be operated upon, by an arrangement of pulleys and cords. This machine was capable of cutting screws of any pitch by the use of pulleys of different diameters, and could be made to cut right-hand or left-hand screws at pleasure by crossing or uncrossing the cord. **Above**—Two Lathes sketched by Da Vinci, found among his many drawings, which he often labeled backwards. In this case, "Tornio"

may be deciphered (with aid of mirror) above each of these sketches.

By means of rosettes placed on the spindle or on the mandrel, oval, octagonal, waved and other irregular forms could be obtained, and figures and geometrical designs were engraved on metal, and medallions and portraits were copied. The rosettes, so called because their contour resembled that of a rose, were really nothing more than plates of brass or iron, two or three "lignes" thick (a "ligne" is a twelfth part of a French inch) and about two inches, or a little more, in diameter. It was these different rosettes that made the various reliefs and depressions, flutings, and carved and notched edges of the wonderful ivory work of that time. What was relief in the rosette was relief in the work, and what was hollowed out in the rosette was the same in the work.

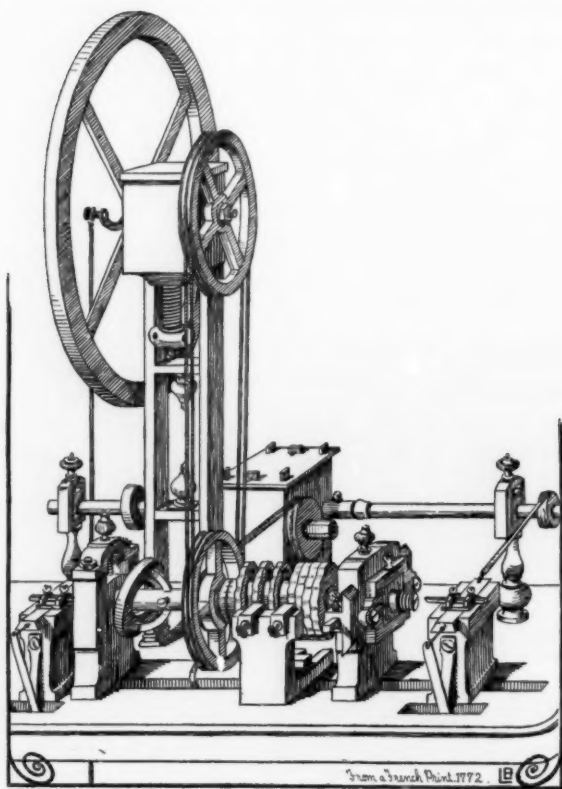


Drawing by Edna Hood Lissak.

From a French Print of 1772.

A Turner's Workshop of the 18th Century. At the back is a lathe for turning wood, while the one in the foreground is for turning metal. The third, at extreme left, was for turning "En l'Air," as it was formerly called,—a lathe where the work was supported only on the head stock. The driving-wheel, in the foreground, is composed of two parts,—the larger for turning small diameters, the smaller for turning large diameters.

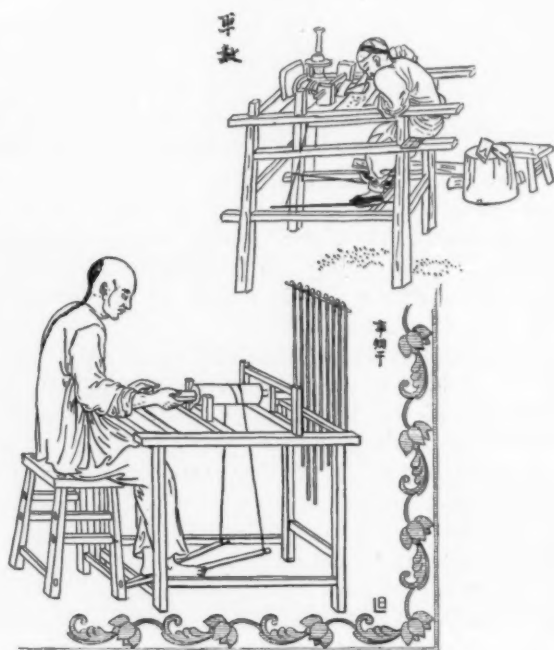
Lathes were made in a great variety of forms and put in motion by different means. Center lathes, with the work supported at both ends, required few tools, while many were needed for the mandrel, spindle or chuck lathe, in which the work was fixed at the projecting extremity of a spindle. This was the old French "tour en l'air," and many a noble of the ancient regime occupied himself at his lathe for his own amusement and for the profit of his heirs.



Drawing by Edna Hood Lissak.

This Lathe of the 18th Century was used for ornamental turning. It was worked by a treadle, and was equipped with ovals and rosettes for cutting irregular edges.

From the different methods of putting lathes in motion they were called pole lathes, hand-wheel lathes, or foot-wheel lathes. For very powerful work they were turned by horses, steam-engines or water-mills. The pole lathe, in general use until the nineteenth century, is still used by natives of certain parts of Africa, in India and Burma, and in the Carpathians. In Burma it is being replaced by more modern methods. No doubt this is true, too, of other far-off places, where we may soon expect to see electrically operated lathes.



Drawing by Edna Hood Lissak From *Old Chinese Drawings*

Old Chinese Lathes. The one below is a tobacco pipe lathe, "Ché Yen Kán."

Science Education in China

By PROF. W. G. WHITMAN, Nanking University,
Nanking, China.

THE quality of science teaching in the middle* schools of China has a wide range of variation. In many of the Government schools and the Chinese private schools there is no science worthy of the name, but in some of the Mission schools, especially those connected with colleges or universities, the quality of work done compares very favorably with the best work done in the United States.

I have visited a number of mission middle schools and colleges in different cities. In the middle schools the science subjects given are generally as follows:

General Science—two years.

Elementary Physics—two years.

Elementary Chemistry—one year.

Sometimes the General Science is given in two units, as physical general science and biological general science. Sometimes the physics and chemistry are shortened to one-half year each, but in such cases they are followed either in the freshman year or sophomore year in college by a full year of General Physics.

Some of these middle schools have good equipment and laboratories of their own. In other cases they borrow equipment from the college. In a number of instances the middle school students go to the college buildings for their work in physics and chemistry, and in Nanking the senior class of the middle school attends the University as a "sub-freshman" class, chiefly for the purpose of taking advantage of the excellent equipment and laboratories in science.

In the Government schools the language used is Chinese. In the mission schools, as a rule, English is used in the classroom, although texts in both English and Chinese are available for study. The texts commonly used are American made and are not particularly well adapted to China. China needs a series of science texts written with the applications and prin-

* The middle schools correspond to Junior-Senior High Schools in America.

ciples drawn largely from the native environment of the Chinese students. Prof. George W. Twiss spent two years in China studying the science situation in the schools. Anyone who is particularly interested in the results of his study will find



SWASEY HALL



BAILIE HALL

interesting reading in his book, "Science and Education in China," published by the Commercial Press, Shanghai, price about \$1.50.

In the colleges the science work is, in all cases where I have visited, of high order. The equipment and buildings are as

good as, or better than, is found in colleges of the same size in America. The headmen in the different departments are well trained. They are in some cases Chinese, and in others American. They are invariably Ph.D. men, and many of the subordinate instructors have taken their Ph.D. degrees in American universities as well. The courses offered in Nanking are typical of what is found in other mission colleges, except that Nanking is the pioneer in Agricultural Science and no other institute in China has done as much as Nanking to help the agricultural industry. A list of these courses will give a good idea of the scope of the work given here.

Agricultural Courses.

School Gardening. General Agriculture. Agricultural Economics and Rural Sociology. Farm Management. Investigation of Rural Conditions. Rural Organization. Agricultural Statistics. Advanced Farm Management. Seminar: Farm Management. Marketing. General Farm Crops. Improvements. Animal Husbandry. Farm Veterinary Practice. General Sericulture. Silkworm Breeding. Silkworm Diseases.

Forestry Courses.

Forestry Economics. Forest and Rural Laws. Mechanical Drawing. Plane Surveying. Forest Survey. Construction. Administration and Theory of Working Plans. Forest Mensuration. Working Plan Data. Forest Valuation. Reclamation of Forest Lands. Forest Investigations. Wood Technology and Wood Preservation. Utilization. Wood Distillation. Forest Entomology. Seminar: Tree Studies and Projects. General Forestry. Principles of Silvics. Forest Influences. Principles of Nursery Practice. Treatment of Woodland. Reforestation.

Biology Courses.

General Biology. Hygiene. Sanitation and Public Health. General Botany. Systematic Botany. Plant Morphology. Comparative Vertebrate Anatomy. Vertebrate Embryology. Genetics and Eugenics. General Bacteriology. Economic Entomology. Plant Physiology. Forest Pathology. Plant Pathology. Laboratory Methods. Plant Ecology. Immunology. Advanced Zoology. Advanced Plant Pathology.

Chemistry Courses.

General Chemistry. Principles of Inorganic Chemistry. Qualitative Analysis. Inorganic and Analytical Chemistry. Analytical Chemistry, quantitative. Organic Chemistry. Analytical Chemistry, advanced quantitative. Elementary Organic Analysis. Agricultural Chemistry. Forest Products Chemistry. Physical Chemistry. Chemistry of Foods and Nutrition. Industrial Chemistry Analysis. Quantitative Organic Analysis. History of Chemistry. Industrial Chemistry Conferences. Food Analysis. Physiological Chemistry. Advanced Physical Chemistry. Advanced Organic Chemistry.

Physics Courses.

Elementary Physics. Electricity, Sound and Light. Mechanics. Molecular Physics and Heat. Heat and Thermodynamics. Electrical Optics. Measurements. Glass Blowing. Technical Reports. Power Plants. Alternate Currents. Radio.

Miscellaneous Courses.

Astronomy. Geology. Meteorology. General Geography. Science Teaching in the Middle Schools. School Hygiene. Methods of Science Teaching. Scientific Terminology. Soil Physics. Soil Fertility. General Horticulture. Pomology. Pomological Research.

Students may elect to carry out a college program in one of these departments: Arts, Sciences, Industrial Chemistry, Premedical, Agriculture, and Forestry. The Arts and Sciences courses are general and prepare the student for life work or a foundation for future technical study. The Industrial Chemistry aims to meet the increasing demand for leaders in the development of Chinese natural resources.

The science requirements for entering the leading medical colleges in China are very exacting. Students are generally urged to complete a full four years course in college before taking up their professional medical course. However, a course is arranged so that students who complete the prescribed science work may, at the end of the sophomore year, enter upon their medical studies. The China Medical Board is doing a splendid thing for science education in China. It is working for better science instruction, finances research, assists in obtaining equipment and spends large sums for science buildings at different

institutions. Nanking is indebted to the China Medical Board for a substantial part of the cost of Bailie Hall, which houses both the Biology and Agriculture Departments. The Agriculture and Forestry Department have other buildings. There are farm buildings at their farms, some seven miles outside the city, and the sericulture building here in the city. The sericulture building is entirely used in producing disease-free silkworm eggs, which are sold to the farmers at cost. The Agriculture Department has developed from a native Chinese cotton plant a variety called the "Million Dollar" cotton. This is a cotton far superior in length of fiber and in production to any other now grown in China. There is a great demand for the seed from all parts of China. In 1925 they selected 10,000 ears of corn from their improved seed fields and made a germination test upon them. Ten per cent was of low germination and discarded; the rest was used in planting and in distribution to different sections of China. The seed is sent out for the cost of transportation. Much improvement in cereal grains has been made. Wheat improvement has already made it possible, by using the improved varieties, to get 325 catties per mow as against the yield of 176 catties per mow for native wheat. They are trying to find even better varieties than these, and probably the most extensive experiment ever attempted anywhere is now under way. Last fall, when I visited the farm, they were planting 20,300 rows of wheat, each row a different wheat. These test wheats were selected from many fields in many different parts of China. It is hoped that some of these will prove better than the present varieties. When we go to the top of Purple Mountain for an outing, we look down on all sides upon thousands and thousands of young trees, where fifteen years ago all was barren waste. This has been accomplished by the Forestry Department of Nanking University. Every year a part of the regular work is to plant a certain area to trees.

The science work throughout the University has a decided practical trend. There are, of course, pure science courses and research courses, but they are only steps in the complete science program which has for its ultimate aim better conditions in China. Nanking has two large science buildings. Swasey Hall, the gift of Mr. Ambrose Swasey of Cleveland, is occupied by the Physics and Chemistry departments. With the growth and

expansion of these departments there is already need of more room. Bailie Hall, the gift of American friends and the China Medical Board, is occupied by the Biology and Agriculture Departments. There is ample room for them at present. This building is named for Prof. Joseph Bailie, who was formerly Dean of Agriculture and Forestry in the University of Nan-king and who was a pioneer in scientific agriculture and forestry in China. Prof. Bailie is the head of The Organizing Bureau of Industrial Service, which is instrumental in giving young Chinese men opportunity to learn industrial processes in America. There are more than 100 Chinese working in the Ford plant in Detroit, and many others in other American industrial plants. Arrangements for this work has all been made through this Industrial Service, started and organized by Prof. Bailie.

You all know that many Chinese students go to America every year for study, through the use of the Boxer fund and other private funds. Many also go and pay their own expenses. Rockefeller money established the China Medical Board, which is doing a much needed work in China. It maintains several modern medical colleges and contributes much to schools preparing students to enter medical schools.

Next to health, agriculture is the thing which needs most attention in the world, and so there has been formed in the United States, The International Education Board. Representatives of this board travel the world over, survey the agricultural fields, hunt out the most promising native men and offer them educational advantages and practical training which will enable them to return and bring better methods and practices back to their own countries.

Just at present, the military leaders are vigorously suppressing the anti-foreign activities of students. Unless the foreigners do something to arouse this slumbering prejudice against foreigners and so fan the spark of antagonism, which is always there, into flame, there is every prospect of a period of calm at educational institutions, and a resulting period of educational progress in China.

You will notice in the picture, just at the left of Swasey Hall, a building which is one-eighth of a mile distant. It is the famous Drum Tower, built by military slaves during the

Sung Dynasty. This was in 1092, or 400 years before America was discovered. The Drum Tower was an ancient watch tower, supposed to control the weird genii of rain, wind, snow and thunder. Its name came from the fact that in time of war a huge drum was used here as a signal for the advance of troops against the enemy. Fifty years ago Mr. Duncan, the pioneer missionary in Nanking, not finding anyone in the city willing to take him in, took up his residence within the tower. This is one of the few ancient structures which remain in Nanking. The old palaces of former emperors have all been destroyed. Nanking has suffered much in wars. At one time victorious armies massacred 800,000 people in Nanking. At present the government buildings do not amount to much. The government schools are in poor condition, salaries are not paid, equipment cannot be obtained. Take the mission schools away from China today and there would be little left of real value from the educational standpoint.

A Fireless Cooker Project

By HARVEY H. GOODWIN.

Following is a brief outline of a project lesson on the fireless cooker, as taught in the junior high school, Amesbury, Mass. The results were very satisfactory.

Conservation of heat is the holding of heat, preferably for some useful object. If we are going to pick up a hot dish, we have something between our hand and the dish itself, either an especially designed handle, as on a frying-pan; or a holder, sometimes a handkerchief or towel. This towel or handle is an insulator—it does not conduct heat readily, it holds the heat in the dish so that we will not burn our hands. (Examples of heat conductivity: hold a piece of copper wire in one hand, and a small piece of wood, such as a twig, in the other, each with an end in the flame of a bunsen-burner; the wire—conductor—soon gets too warm to hold; while the wood—non-conductor—does not get warm.) Here, the class will give examples of conductors,—steel, copper, iron, various metals, stones, etc.; also of non-conductors or insulators,—paper, asbestos, wood, cork, etc.

Now, if we take a wooden box and line it with cork, asbestos and paper, it will take a long time for any heat to get through it. Paper will burn easily, and asbestos will not; so we will put the asbestos on the inside of the box, inside of the paper. Now, if we put a hot flat-iron inside of this box and cover it up tightly, what will become of the heat in the iron? Of course it will stay in the box, because it cannot get out. If we fix another box the same way, and put in a piece of ice and close the box, what will become of the ice? Some will say that the heat which cannot get out will melt the ice; while others will say that the ice will stay there, because the cold cannot get out, and the heat from outside cannot get in. In a way, both are true. The box, being warmer than the ice,

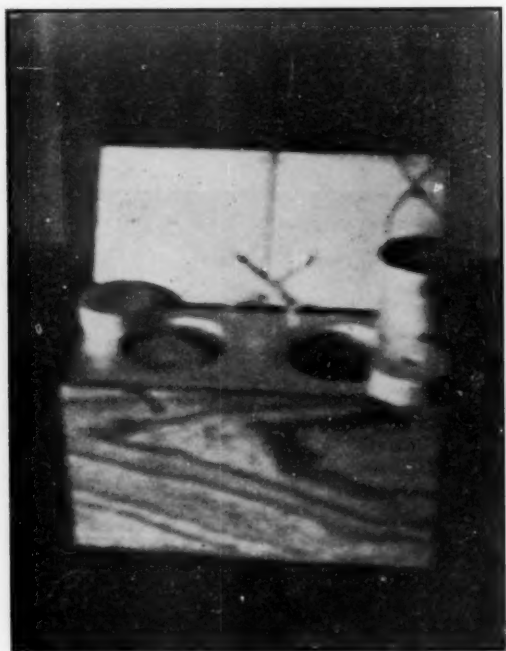


A Group of the Fireless Cookers

starts it melting, but the inability of the outside heat to get in keeps the ice from melting very fast. This, then, is our refrigerator—merely an insulated box.

The first example mentioned is the beginning of our fireless cooker. In this we put plenty of insulation, leaving a small hole into which we put a warm iron; and on top of the iron we set a kettle of oatmeal, or something else we wish to cook, then cover it as tightly as we can. What will happen? Why, the heat from the iron cannot get out, so it stays in that little hole and heats the kettle of oatmeal, finally cooking it. In cooking most things with this cooker, however, it is better to start the kettle on a stove, thereby giving it and the food it

contains some heat to help the cooking in the box. At this point, the latest thing in fireless cookers, the automatic electric cooker, may be mentioned. The kettles are put into the holes cold. Then a couple of dials are set, according to directions which come with the cooker, so that at a certain time the electricity is turned on, and heat is furnished inside of the box for a certain length of time, when the current is auto-



Model Fireless Cooker made by Fernald Taylor,
Junior High School, Amesbury, Mass.

matically shut off, while the food continues to cook as in any fireless cooker.

As a project, each student is asked to make a model of a fireless cooker, at home, from whatever materials are at hand—no expense to be involved—and to bring it to class. Suggestions are made as to how it might be done—what might be used as the outside box—what might represent the insulation; a piece of cardboard or similar substance to hold the insulation

in place and make the holes; a small flat stone, possibly for the iron—the source of heat; and the cover—possibly a little cloth bag filled with sawdust, or a flat piece of wood or cardboard.

The pictures with this article show some of the results. The box itself consisted of cardboard candy boxes, alarm-clock boxes, large tobacco cans, small wooden boxes formerly containing chalk, etc., wooden boxes made for the occasion, and, in one case, a big tin bread-box. The insulation consisted chiefly of crumpled and torn bits of paper, although rags, sawdust and shavings were used. This was held in place by cardboard, tin or aluminum (plenty of scrap aluminum was to be had from the auto-body factories in the town). The heat units were small flat stones, slices from an old broom-handle, and in one instance, two pennies. The kettles consisted of small bottles, small tumblers, dishes from a doll's set, and small tin cans. To make it more realistic, one young Yankee filled the small "kettle" with beans, all ready to bake. The cover was insulated with crumpled paper or sawdust in little cloth bags.

One especially good cooker (see illustration) merits a detailed description.

This cooker had a specially made fine-grained wooden box, varnished. It contained two compartments. A hinged lid covered each, with a bent piece of wire to hook around a small protruding nail, for a fastener. The insulation was sawdust, and it was held in place by an aluminum form with aluminum-lined holes. Small baking-powder tins, shortened and painted with aluminum paint, represented the kettles. Four slices from a large ladder rung (one for the top and bottom of each hole) were the iron heating units. In the center of the top of each "iron" was a small countersunk hole containing a small U-shaped nail, driven in far enough so that it did not protrude over the top. These "irons" were also painted with aluminum paint. A piece of wire was bent with a loop at one end and a tiny hook at the other, to lift out these "heat units." Two other pieces of wire were bent with loops at one end for handles, and hooks at the other end, loosely riveted in the middle, forming a pair of forceps to lift out the "hot kettles" when the food was cooked. This cooker was so exact as to detail that it was

purchased by the high school domestic science department for use as a demonstration model.

Eighteen representative cookers were put on display in a local hardware store window for a week, and the local paper gave them a write-up. Some concern which handles fireless cookers would probably be glad to incorporate these model cookers in a window display, featuring one of their own cookers.

Projects in Physics

By BURGoyNE L. GRIFFITHS,
University of Nanking, China.

WHEN we consider the aims of teaching physics we realize that knowledge about the laws of nature is important and indispensable, but probably all agree that there are other and even more important things to be considered in training science men. The student should be taught to observe accurately, to have a persistent desire to secure results that are accurate and dependable, and to interpret the phenomena he sees in accordance with laws. The value of the information that students have acquired lies in their ability to apply and use it. Does the student reach the point where he can be given some experimental problem, work out the details himself and carry the work through to a dependable result, or is it always necessary to give him detailed instructions for him to slavishly follow? When given an original problem, does he search feverishly for references, instead of trying to work out the result himself without help from the outside?

The project may be made an experimental problem to discover something which cannot be found in reference books. A concrete example of a project would be the construction of a Chinese balance (steelyard). The project might include or be preceded by an experiment in moments.

The project, if properly used, will stimulate interest in the subject. If a student has native ability in scientific subjects, he will be stimulated into activity as by no other method. Prof. A. A. Michelson, of the University of Chicago, one of the winners of the Nobel Prize, is a graduate of Annapolis and was formerly a teacher in physics there. At that time, he

said, he was not especially interested in physics. While he was teaching physics he tried to demonstrate to the class the method of determining the velocity of light. He made up the apparatus from materials at hand, and was surprised to find that results he obtained were more accurate than any previously obtained. These results were published and accepted by scientists. This was the turning-point of Michelson's career. This project aroused powers within him that before were dormant. He went on in original investigation, and now is probably the world's authority on light. A project may provide the stimulus that will enable the student who is undecided as to what he is fitted for, to "find himself."

Projects may be given in such a way as to develop the creative imagination. Without the development of this faculty progress in new discoveries in science would be impossible. It is this faculty that enables the teacher to try new methods and develop his art of teaching. One of the greatest inventors of modern times is Nikola Tesla. His discoveries are of a more fundamental nature than those of Edison. When he was in a technical school, he started thinking on the problem of a motor that would run without commutator or slip rings. He was told that this would be impossible from a theoretical point of view. However, he continued to study the problem, building pictures in his imagination, and one time, while walking with a friend, the whole idea stood out clearly in his mind, and later he built the induction motor. He said afterwards he never felt such a thrill of achievement as at that time.

The purpose of this paper is not to urge that we should turn our students into inventors, but to develop to some extent this faculty which, in its broad sense, is a prerequisite to success in almost every field of work. The value of research work in developing an individual in any certain line is unquestioned. Every candidate for a degree higher than A.B. in nearly every case is required to write a thesis requiring original work on the part of the applicant. Why should it not be desirable to give the student a chance to launch out for himself before he is mature, with fixed habits and brain cells that are set? But, instead of providing some very theoretical problem, such as would be given in graduate work, it is much more desirable to give them practical problems, as closely associated with their background as possible.

In order for a project to be successful, the student must be interested in the result, and sufficiently interested that he will carry the task through to completion. If projects are required, it assumes the nature of task work, and the whole purpose is lost. Interest can be aroused by having some groups give reports on projects performed. If their names are placed on the finished product, and it is exhibited to later classes and kept as permanent apparatus, this will be found a good incentive to careful work. Another means of arousing interest is to give a reward in the way of an increase in grade. But above all, project work should be voluntary.

To be successful, the project should never be too advanced for the student, so that he cannot completely grasp the idea of the thing he is working for. In many cases, it is well to precede the project with class work along the same line. For example, after the student has studied about specific heat and thermo-conductivity, and perhaps performed some such experiment in the laboratory, he might be asked if he desired to make a stove that can cook without fire. He would be provided with a box about 12x12x16 inches, and a small can fitted to leave a 3-inch space for packing material. The student must, of course, have a general idea of what a fireless cooker is, but the more left to him, the better. He is provided with samples of various kinds of stone and metal, in order to test the specific heat, in order to determine the best kind of heating element. He should also be given packing materials of different kinds to test for the best insulating properties. A plan should be submitted in writing and approved by the instructor, and then the experimental part may be performed. When this is done, the student will have a working knowledge of specific heat and thermo-conductivity in a more vivid way than if he had read it out of a book.

The question may arise, What is the relation of mathematics to the project work? A study of conditions in actual practice might be of some value here. Mathematics is used as a tool. The engineer in planning a bridge, does not build a bridge and then try it to see if it works. No; every stress and strain must be accurately calculated in advance. He must approach his work with a plan. In our laboratory work the experimental part is usually done first and calculations afterwards. But in

some cases, projects will lend themselves in an admirable way to mathematical planning, and it should be used wherever possible. For example, a student may be given the problem of constructing a three-range voltmeter out of one of the 10 volt 10 ampere Central Scientific instruments. In the first place, it will be necessary for him to study the volt-ammeter, to see how it is made, and make a wiring diagram of the circuits. Then he should be able to tell how three coils could be added to make the instrument a three-range instrument. Then he must measure the resistance of the galvanometer part of the instrument, and the current per scale division. Then there are two ways of proceeding: the student might add resistance until he finds the right amount; or, he may calculate the exact amount of resistance to be added, then measure the resistance per unit length of a sample of manganin or advance wire, measure off the exact amount, and put it in. The latter way, of mathematically planning the result is, of course, the best way. When the voltmeter is tested out, the pointer of the instrument tells him graphically whether he has done the work correctly or not. In addition, the instrument may be calibrated by means of a tangent galvanometer, the calibration curve bearing the students' names put on the instrument. The instrument is then used as permanent apparatus for later classes. A three, two, or one-range ammeter may be constructed from a similar type of instrument. The calculation and construction becomes more difficult than for the voltmeter, but in every case calculation should come first.

If a student were asked to find out how the change of the two constants, A (the weight arm) and W (the weight) of a balance (steelyard) affected the calibration, he might proceed in two ways: one, to try it out or calculate the way by the laws of moments and then test his theory by experiment. Actually increasing weight W decreases the distance between the scale divisions, but the smallest weight w is unchanged. If A is changed, both the smallest reading and the size of the scale are changed. It is possible for the student to predict the result, then perform the experiment to verify the result.

As a rule, mathematical projects should not come in the elementary course until the student is able to work mathematical problems with facility.

A project of some practical value is the making of a dry cell. The zinc case may be made and filled with ingredients, the proportions taken from analysis of an old dry cell. One of the students in a class in electrical measurements became interested in primary cells because members of the class were constructing a standard cell. He tried out various combinations and succeeded in making a cell in a U-tube that gave 2 volts and $\frac{1}{2}$ ampere. He showed me the result and expressed a desire to make a further study of cells. His eyes were shining. "I know that I can find something new." And it is easy to believe that he could.

At present there are two students studying changes of the earth's magnetism. A needle on the back of a mirror is set in a position where the earth field is neutralized by a permanent magnet. The needle is very sensitive to changes of the earth field, and the deflection viewed in a telescope fluctuates often 10 to 20 centimeters in one day.

In the city of Nanking the city lighting voltage fluctuates between 120 and 190 volts. Many persons desire to use electrical irons, grills, etc., which operate at 110 volts. A choke coil was calculated and constructed by the class studying alternating currents, with taps distributed so that even changes of voltage were made with each tap. The use of the choke coil eliminates loss in heat that would occur in a resistance.

In optics, one of my students constructed a foot candle meter, having a flashlight bulb at one end in a box, with a scale having a number of holes on the top of the box. By observing the illumination of the holes, the intensity of illumination of a room may be directly read. However, the scale is much more crowded near the light than farther away. This trouble can be avoided in the following way. The distribution curve of the flashlight bulb is found. From the illumination curve, the curve on which the scale is placed is found that will give a uniform variation of foot candles. In this way the range may be extended by using different voltages on the lamp.

One of the most interesting of all is the calculation and construction of a lense. Prof. Woodworth has worked out a very useful graphical method by which a ray can be traced accurately through any lens system. A simple problem is to determine the index of a piece of plate glass, measure its thick-

ness, then calculate graphically the radius of curvature necessary to bring the focus on the back surface, and then actually construct the lens. Photographing spectra of various elements in natural colors by use of the autochroms or payet color process is a very useful project. These plates can be used later in the study of the spectra of elements.

The thinking out of new projects, based on Chinese life and civilization, is a field that has hardly begun to be developed. It is a real task, and one that is greatly needed. It is very fascinating work, and the rewards are very gratifying. In perhaps no other way could we get as good a return for effort as in adapting the project method to Chinese life. When that is done, physics will take on a new meaning to students.

Earthquakes*

For our present purpose, earthquakes may be separated into two groups: (1) the minor or superficial types, and (2) the major types. Superficial earthquakes are due to accidents occurring within a few tens or hundreds of feet of the earth's surface. The collapse of the roof of a limestone cave, landslides, and explosions within the crater of a volcano are the most frequent causes. Earthquakes of this type are not felt far from the origin of the disturbance, and are not usually very violent.

Major earthquakes, on the other hand, have their origin at depths of from five to ten miles, and may be detected by delicate instruments for thousands of miles from their point of origin. Perhaps instead of saying "point of origin" it would be better to say "plane of origin," because nearly all major earthquakes are caused by the slipping of blocks of the earth's crust along the surfaces of the cracks which separate them. You may have been skating and heard a crack start at a distance from you. Soon the ice was snapping all about you. Earthquakes are quite similar. The ice cracks because it expands as it freezes, or because the water upon which it floats

* An address by Prof. Wilbur Garland Foye, of Wesleyan University, broadcast on November 30, 1925, from WTIC, the Travelers radio broadcasting station at Hartford, Connecticut. Reprinted from *The Travelers Standard*, January, 1926.

has been disturbed. If the water is rising or falling, the ice will be subjected to strains and may be buckled or pulled apart. I do not mean to say that the earth's crust floats on a fluid interior as the ice floats upon water, because we know that the interior is rigid as steel. There are processes of expansion and contraction going on there, however, which affect the outer crust. Rearrangement of the atoms and molecules usually tend to decrease the volume of the interior. Heat is thereby produced, and this migrates outward and manifests itself to us when it nears the surface. It is this heat that melts the materials found in volcanoes.

Just here let me correct an error which is sometimes made. The opening of cracks in the earth's outer crust (which is heralded by earthquakes at the surface) must precede the outflow of lavas along these cracks. Hence, it is probably not true that earthquakes are produced by explosions resulting from the inflow of waters towards the molten rocks at the cores of volcanoes. Both earthquakes and volcanoes are attendant upon the shattering of the outer crust of the earth. Blocks of the crust bounded by cracks (or by "fault planes," as the geologist calls them) rise or fall with respect to adjacent blocks, and hills or valleys result. The lower Rhine valley is such a block, dropped between the Black Forest on one side and the Vosges on the other. The Jordan valley is a similar block. When the Psalmist sings:

"Then the earth shook and trembled,

The foundations of the mountains also

Quaked and were shaken, because Jehovah was wroth,"

he is undoubtedly describing one of the earthquakes that came so frequently to his land.

Earthquakes are the "growing pains" of mountains. Near the California coast at the present time (and also along the Japanese coast), great ocean depths are found, close to great mountain heights. The lighter continental materials are really in balance with the heavier rocks of the Pacific floor. But swiftly-flowing streams, descending the slopes of the land, carry with them the waste of the mountains and cast it into the trough of the Pacific. Thus the weight is continually being taken from one scale-pan and thrown into the other. Torsional strains result which give rise to "faulting" and earthquakes.

Ultimately the mountains will be worn down by the activity of the rivers, and the two scale-pans will then come to a fairly permanent equilibrium. The eastern coast of the United States has reached a condition of relative stability already. It is true that the ice of the glaciers which lay over the continent from Labrador to Long Island some 20,000 or 30,000 years ago, to a thickness of from a quarter of a mile to half a mile, did upset the balance somewhat by depressing the continent. Minor movements of readjustment have been necessary since the ice melted away, and have been attended by earthquakes of greater or lesser violence. The readjustments have tended to be localized along very ancient zones of faulting. Three such zones are well marked in New England. One follows a line running a few miles west of the Green Mountains and toward the St. Lawrence valley and then skirting south of the St. Lawrence toward Quebec. A second lies just east of the Connecticut River valley; and a third emerges from the Bay of Fundy and extends southward through the Gulf of Maine toward Plymouth, Massachusetts. When these faults were first formed, many millions of years ago, New England was undoubtedly as subject to violent earthquakes as Japan is at the present time.

Charles Kingsley once wrote a playful letter to his children, from Spain, where he was visiting the Pyrenees mountains. "Last night," he said, "I did something extra,—a dear, little suckling earthquake went off, crash-bang, just under my bed. It shook the whole house and village, but no one minded. They said they had lots of young earthquakes there, but they went off before they had time to grow." Our New England 'quakes are something akin to the Spanish types.

The science of earthquakes is known as *seismology*. The instrument used to record earthquakes is known as the *seismograph*. Instruments of this sort may be found in the American Museum of Natural History at New York and in the Agassiz Museum at Cambridge, Massachusetts. The essential of such an instrument is a heavy weight of from 20 to 30 pounds, which is suspended freely in space from a support that is firmly fixed in the earth. The support is shaken by an earthquake, whereas the heavy weight, on account of its inertia, tends to remain still. A drum that is continuously rotated by clockwork records the vibrations of the support. Records

of this sort show that distant earthquakes give rise to three types of wave movements. The primary or *P* waves and the secondary or *S* waves radiate outward from the point of origin. The first tend to throw objects upward from the surface, while the second tend to twist them around. The long or *L* waves follow around the surface of the globe, and are the ones most felt by man.

J. J. Audobon, the naturalist, was traveling in Kentucky at the time of the New Madrid earthquake in 1812. He states that his horse stopped, spread his legs, and gave indications of being sick. Audobon dismounted to find out what the trouble was, and before long "the ground rose and fell in successive furrows like the ruffled waters of a lake." The horse had sensed the primary or *P* waves, which his rider could not perceive, and the long or *L* waves, which travel at a slower rate, soon acquainted Audobon with the true nature of the disturbance.

It is this interval between the time of the arrival of the *P* and *L* waves which allows the scientist to estimate the distance from any given point to the center of the 'quake. The farther away the center is, the longer the interval between the arrival of the two types of waves.

It is customary to record the intensity of earthquakes on a scale ranging from one to ten: (1) Instrumental shocks—noted only on a seismograph; (2) Very slight shocks—felt only by a few people on upper floors; (3) Slight shocks—felt by persons indoors but not causing alarm; (4) Moderate shocks—floors creak and suspended objects vibrate; (5) Rather strong shocks—felt out of doors, doors rattle, church bells ring; (6) Strong shocks—objects fall in houses and plaster cracks; (7) Very strong shocks—buildings crack, chimney-bricks fall; (8) Ruinous—houses collapse; (9) Disastrous—many houses collapse and there is loss of life; (10) Very disastrous—landslides occur, and there is general loss of life over a wide area.

The New England earthquake of February 28, 1925, was of intensity 7 to 8 near the headwaters of the Saguenay river in Quebec, but decreased rapidly toward the east and west. The fault extended toward the southwest, so that the intensity did not decrease as rapidly in that direction.

Newspapers are helpful in finding the center of a disturb-

ance, since from their records lines of equal intensity may be traced on a map, and the zone of greatest intensity is soon surrounded by curves.

Recent Californian surveys tend to show that the region southwest of the Santa Cruz mountains is moving northward, whereas the region to the northeast of them is moving southward. The earth's crust stands the strain of these movements for a time, but ultimately its elasticity is overcome and earthquakes follow. Thus in a region of rapidly growing mountains the elasticity is frequently passed and many earthquakes occur, whereas in regions of less rapid movement the strains accumulate over a long period, or are released over shorter periods with less violence. When one movement takes place it is apt to act as a trigger to release other strains which have accumulated in neighboring parts of the crust. Thus earthquakes come in groups, as we have recently discovered. Once the strains are released, it requires a lapse of time for them to build themselves up again.

Available Motion Picture Films

America's Harvest of Gold (2 reels).

Shows vast wheat field of the Western United States, with methods of cutting, binding, threshing the grain.

Auto Starting and Lighting (2 reels).

This film is composed of animated drawings showing the different principles and steps involved in lighting and starting an automobile from a storage battery. Recommended especially for use of physics classes.

Back of the Button (1 reel).

The God Thor sends his slave "Kilo-Watt" to serve men. This service is rendered through the modern electric labor-saving devices in the home.

Blood and Its Ingredients (1 reel).

Intended especially for use in the study of physiology. Gives microscopic views of the blood under many different conditions.

Cattle Industry (2 reels).

Film was made in Australia, and illustrates in entertaining manner how this important industry is carried on in that country.

Circulating and Publishing a Magazine (4 reels).

Shows in detail the wonderful machinery used and the various processes entering into the publishing and circulating of the modern magazine. Taken in the plant of the Curtis Publishing Company, Philadelphia, Pa.

Citrus Fruit and Fruit Drops (1 reel).

The important part played by citrus drops and sugar in the diet. Full of action (partly in color).

Communication on the Battle Front (1 reel).

A war film, showing how messages are carried from behind the lines to the officers in the front line.

Concerning Cheese (1 reel).

Splendid film with many close-ups showing all steps from the time the milk is taken from the cow until the cheese is ready for market.

The Danger That Never Sleeps (1 reel).

A fire protection film.

The Development of the Art of Writing (1 reel).

This film shows the development of the art of writing from the Egyptian hieroglyphics 5000 B. C. to the methods used in 1920 A. D.

The Diary of a Murderer (1 reel).

Shows a fly in its murderous career in bringing disease to the lips of a baby.

Eyesight, the Master Sense (1 reel).

A scientific film, intended for classroom work, showing in detail the structure of the eye, and explaining just why it is that we can see.

The Fly Danger (1 reel).

How the fly spreads disease; life of a fly; precautions against fly infection.

The Fountain of Youth (2 reels).

Personal hygiene is the theme running throughout this film. It commences with a picturization of the early Roman baths and methods of bathing. How the Romans developed a hot-water system. By means of drawings and diagrams the plumbing system in modern homes, both city and rural, is illustrated, to stress the importance of proper sanitation. The hot-water system, a mystery to many housewives, is carefully explained. Several scenes, showing the bathing facilities in hospitals, factories and homes are followed by important information on personal cleanliness.

From Calves to Kiddies (1 reel).

Shows how hides are tanned and prepared for shoes and finally the different manufacturing processes involved in making shoes from these same hides.

From Coal Field to Corn Field (2 reels).

Shows in detail how coal is mined, converted into coke, the fumes from the ovens being used to make fertilizer; results obtained by use of such fertilizer on different crops.

Hanging Glaciers (1 reel).

The first photographic expedition into the newly discovered wonders hidden away in Canada, 7000 feet up in the Canadian Selkirk Range—the Lake of Hanging Glaciers. At Wilmer. Packing through the wilderness. Horse Thief Creek. Glacial Cave—source of Columbia River. Piedmont Glacier. Lake of the Hanging Glaciers. Grotesque shapes of icebergs and glacial formations. The Three Jacks Range.

The History of Spice (1 reel).

The important part played by spices in the development of trade routes, and the discovery of new continents. Many scenes of foreign lands. An interesting picture.

Inside Out (1 reel).

An excellent film, teaching a necessary health lesson, prepared in co-operation with doctors and hygiene and domestic science teachers. The whole digestive process is shown—work of the teeth, saliva, esophagus, stomach, intestines, cause of constipation, results of clogging digestive tract well explained, delicately handled. Various remedies are suggested, need for exercise and balanced diet stressed.

Jinks (1 reel).

Animated cartoon on tuberculosis.

Jupiter's Thunderbolts (1 reel).

Benjamin Franklin's experiment. Making of modern electrical appliances and batteries.

Making the Desert Bloom (2 reels).

The wonderful things which can be accomplished by irrigation.

Manufacture of Face Brick (3 reels).

This picture affords a detailed account of the story of the art of brick-making from the days of the Chaldeans, ten thousand years ago, to its present standard of utility and beauty. Contains many scenes of historic interest, such as the Hanging Gardens of Babylon and the Tower of Babel.

Manufacture of Pure Foods (1 reel).

Taken in the laboratories at Battle Creek, Michigan.

Manufacture of Text-Books (1 reel).

Showing the setting of type, reading of proof, making the electrotypes, putting the plates on the press, the operation of printing presses, binding the printed sheets, trimming, sewing, covering the books in the bindery, and a few other operations in the process of the manufacture of books.

The Marvels of Crystallization (2 reels).

Showing a close view of the formation of various kinds of crystals.

Master Robin Hood (2 reels).

A fascinating film story of the birth and life history of the Robin Redbreast.

A Modern Fish Hatchery (1 reel).

The development of yellow perch in hen's eggs.

Modern Railroad (2 reels).

A scenic film, taken in various parts of the United States, showing scenes along the railroad and some of the wonderful civil engineering feats accomplished in building these railroads.

Mouth Hygiene (1 reel).

That good teeth promote good health is the theme of this dental hygiene film. Is especially valuable for health education in school and community.

My Lady's Dress (2 reels).

Manufacture of silk cloth from the time the cocoon is made until the cloth is worn.

Play Safe (1 reel).

A safety first film made by the General Motors Company. Very useful film to impress the dangers of playing in the streets and similar things on the minds of children. Recommended for school use.

Prize Potatoes (1 reel).

Shows seed selection, treatment for disease, preparation of seed bed, cultivation, fertilization, and resulting crop.

The Rat Menace (1 reel).

Habits of rats spread dangerous diseases. Necessity for stamping out rats and how to do it.

Renewing of Youth (2 reels).

Story of the manufacture of paint.

The Romance of Glass (1 reel).

Showing how legend says that glass was discovered; how it was first produced by the Phoenicians; and also views of modern glass manufacturing.

Romance of a Grain of Wheat (2 reels).

An educational film giving a very good story on flour, from the preparation of the ground to the finished product.

Sir Lacteus—the Good Milk Knight (2 reels).

Little girl dreams and is kidnapped by Sir Lacteus, who aided by his followers, Lime, Protein, etc., defeats Sir Disease. Picture for children only.

The Sixth Sense (1 reel).

Six little sprites assist in baking cakes and testing Calumet Baking Powder. Interesting and very cleverly presented.

The Story of the Incubator (2 reels).

This picture shows in detail the construction of an incubator, the principles involved in heating, and the way the eggs should be tested and placed in the incubator. Contains many close-ups and is a very instructive film.

Transportation (available only during January and February, 1926) (2 reels).

Made in co-operation with the Westinghouse Electric and Manufacturing Company. Shows methods of transportation, beginning with the sled drawn and pushed by slaves under the lash, and then depicts development up to the high-powered electric locomotive. Many interesting scenes are included.

War on the Mosquito (1 reel).

Shows methods for destroying them; different stages in development; typical breeding places and how they should be treated.

Water Power (available only during January and February, 1926) (2 reels).

Made in co-operation with the Westinghouse Electric & Manufacturing Company. Shows the method of using the energy of falling water in ancient and modern times. It makes clear the operation of the turbine connected to an electric current generator and the transmission of the current at high voltages over long distances.

Wings of Victory (2 reels).

Showing our airplane equipment for the World War and the accomplishments of this branch of the service.

These films are loaned by the Bureau of Visual Instruction, General Extension Division, University of Florida, Gainesville, Florida.

The Department of Agriculture has two motion picture films available—"Sugar Cane and Cane Sugar" and "Beets from Seed to Sugar Bowl"—which may be obtained free of charge, except for the payment of transportation expenses.

E. I. du Pont de Nemours & Co., Publicity Bureau, Wilmington, Delaware, has prepared the following films on safety stock, which may be obtained by responsible institutions, societies and individuals, for public showing:

The Story of Dynamite (2 reels).

Shows the manufacture of dynamite from the raw materials to the finished product, packing for shipment, laboratory tests, and use in mining, railroad construction, tunneling, etc.

Dynamite—A Basic Material of Modern Civilization (6 reels).

More comprehensive than the first film, and of especial interest to those interested in the technic of using dynamite.

From Forests to Farms (1 reel).

Shows the use of dynamite in clearing cut-over land.

Letting Dynamite Do It (1 reel).

Shows the use of dynamite in lumbering, blasting a mountain, removing a reef from a Florida harbor, road building, etc.

Dynamite at Work (1 reel).

Use of dynamite in industrial development.

Dynamite in Quarry Work (1 reel).

Dynamite—The Modern Ditch Digger (1 reel).

Dynamite—The Master Lumberjack (1 reel).



Summer Courses in Science

(Undergraduate courses in the special sciences are not listed.)

The University of Chicago, Chicago, Ill.

- | | |
|--|-------------------|
| Investigations of the problem of science teaching. | Professor Downing |
| The Teaching of high school Physics. | Mr. Lohr |
| Teaching science in the schools. | Prof. Downing |
| The Teaching of General Science. | Prof. Cunningham |
| The Organization of Elementary Science (Nature Study) in the grade curriculum. | Mr. Frank |
| The teaching of Physiology and Hygiene. | Mr. Frank |
| Biology, Botany and Zoology in secondary schools. | Prof. Downing |
| The teaching of high school Chemistry. | Prof. Cunningham |
| The Science Curriculum. | Prof. Downing |

The University of California, Berkeley, Cal.

- | | |
|--|--------------|
| Methods of teaching in Elementary Science. | Mr. Tippet |
| Conservation of Vision. | Prof. Woll |
| Microscopic technique. | Prof. Shumay |

Columbia University, New York City.

- Conferences and discussions on current questions in the teaching of elementary and secondary school science.

- | | |
|--|------------------------------------|
| | Professors Caldwell and Powers |
| | Messrs. Glenn, Lockhart and Craige |
| Principles and organization of science in secondary schools. | Prof. Caldwell |
| The teaching and supervision of science in junior and senior high schools. | Prof. Powers |
| Biological foundations of education. | Prof. Caldwell |
| The teaching of general science in secondary schools. | Mr. Glenn |
| The teaching of biological sciences in secondary schools. | Mr. Finley |
| The teaching of Physics in secondary schools. | Mr. Glenn |
| The teaching of Chemistry in secondary schools. | Mr. Glenn |
| Regional studies in science. | Mr. Finley |
| The teaching of science in the elementary school. | Mr. Craig |
| Special problems in science teaching in secondary schools. | Prof. Powers |

University of Michigan, Ann Arbor, Michigan.

The teaching of science in the elementary school.

Perna M. Stine

The teaching of science in the junior and senior high school.

Francis D. Curtis

Demonstration teaching of general science in the seventh grade.

Francis D. Curtis

Problems in the field of secondary science.

Francis D. Curtis

Senior Teachers College of Western Reserve University,
Cleveland, Ohio.

Nature study for elementary science.

Mr. Persing

Physical Science for elementary science.

Mr. Persing

General science for the junior high school.

Mr. Harley

The teaching of elementary chemistry.

Mr. Hayes and Mr. Long

University of Pennsylvania, Philadelphia, Pa.

Principles of Science Teaching.

Mr. Palmer

Massachusetts Institute of Technology, Cambridge, Mass.

Methods of Teaching General Biology.

Professor Prescott and Miss MacRae

Health Records and Statistical Procedure.

Mr. Riley

Electron Theory.

Professor Knobel

Methods of Teaching General Science in the Junior and

Senior High Schools.

Mr. Lunt

Methods of Teaching Physics.

Mr. Miller

Methods of Teaching Chemistry.

Mr. Stone

Health Education Methods.

Professor Turner

Indiana University, Bloomington, Indiana.

The Teaching of Botany (high school).

Mr. Weatherwax

The Teaching of Chemistry.

Mr. Briscoe

The Teaching of Physics.

Mr. Tugman



List of New Books

Physiological Chemistry with Experiments—C. J. Pettibone—404 pages—E. V. Moseby Company.

This is an intermediate textbook to cover the field of physiological chemistry from a biochemical point of view. It is essentially a textbook for medical students. It takes up the various elements and compounds found in foods, and changes in digestion and in the building up of animal tissues, always from the point of view of biochemistry.

Matter, Man, and Mind—W. F. Shearcroft—183 pages—Macmillan Company.

This book, written by an English writer, is very interesting. The subject matter is extremely readable and many interesting ideas are presented. Some of the newer discoveries and theories in science are so presented that they are easily understood by the reader who is not trained in science. Some of the chapter headings are: Floating Continents, The Forces of Nature, Primordial Mud, Inheritance, Evolution, The Tree of Life, The Chemist's Triumph, The Mind of Man, The Crowd, and others. There is a good deal of subtle humor scattered throughout. Any science teacher would find it both interesting and beneficial, and it might be profitably read by many of the more thoughtful science pupils of high school age. A bibliography is also given.

Information Exercises in Biology—Cooperider—Public School Publishing Company.

This test paper consists of six exercises: Exercise 1, completion, sixteen items; exercise 2, true and false, sixteen items; exercise 3, information through choice of correct word from three to five given, seventeen items; exercise 4, best reason out of four given, nine items; exercise 5, classification by striking out one word which does not belong from a group of five, eighteen items; exercise 6, logical selection through indicating two words from a group of five always associated with a given word, seventeen items.

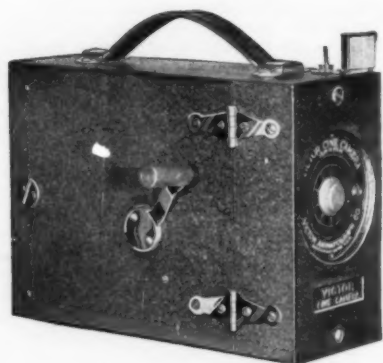
This test is based on a high school biology course and seems to be well balanced. A second sheet gives detailed instruction for giving and scoring the tests. These tests were described in an article by Mr. Cooperider in the November, 1925, issue of "School, Science and Mathematics."

Science of Home and Community—Trafton—578 pages—215 cuts—Macmillan Company.

This is a revision of the text published first in 1919. "This book is an attempt to make clear to boys and girls, answers to some of the questions that naturally arise in their minds concerning the common applications of science. This book is not written as an introduction to, or preparation for, any later science work." In this revision, the vocabulary is simplified. Radio has been added under the topic, "Means of Communication." The organization is about the same as in the earlier book, a slight change in order having been made. The paragraph arrangement and changes in style of type used make it a much better appearing book. An outline summary has been added at the close of each chapter.

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A Naturalist in East Africa—Carpenter—182 pages—illustrated—\$5.00—Oxford University Press.

This book is written from notes made in Uganda and Portuguese East Africa. It is written in a very interesting way and makes entertaining reading to anyone interested in this subject, even though not a specialist. The exactness of the notes also make it of value to the specialist. It is written chronologically. While anything of particular interest to a naturalist which has come under the author's attention has been spoken of, the book has mainly to do with insects and of those butterflies receive the most attention. The focus of attention seems to be on protective coloration and mimicry. It contains, in addition to the illustrations, eight full-page plates and a map of the country over which the author traveled.

Farm Economics—Howe—221 pages—54 illustrations—\$1.20—American Book Company.

This is the fourth volume of a series of books of agriculture. It presents simply and clearly the fundamental principles underlying successful farming. The business of running a farm in such a manner as to make it pay. It includes questions of farming incomes and profits; farm records and account; prices and marketing of farm products; farm labor and supervision; soils, crops, live stock and farm machinery; representative types and systems of farming; farm ownership and tenancy; and desirability of farming as compared with other kinds of business.

Science Articles in Current Periodicals

[These classified articles should make valuable supplementary reading for the pupils. In some cases the material is in such form that it would be too difficult for many of the pupils to abstract the matter for themselves. In such cases the article may be read by the teacher and passed on to the pupil in class. Such articles are starred. Articles for professional reading are at the end of the classified list.]

AGRICULTURE

Shall We Throw Away Our Soil? *Sci. Am.*, Feb. 1926, p. 96.

*Broadening Agricultural Chemistry. *Jour. Chem. Educ.*, Feb. 1926, p. 201.

ASTRONOMY

How Large Can a Star Be? *Pop. Sci. Mo.*, May, 1926, p. 22.

Mirror Making for Reflecting Telescopes. *Sci. Am.*, Feb. 1926, p. 86.

What Are Shooting Stars and Meteorites? *Sci. Am.*, Feb. 1926, p. 94.

The Big Sun Spot. *Lit. Dig.*, Feb. 20, 1926, p. 25.

Measuring the Distance of the Sun. *Guide to Nature*, Jan. 1926, p. 125.

Star Clusters. *Sci. Am.*, Mar. 1926, p. 157.

Mountings for Reflecting Telescopes. *Sci. Am.*, Mar. 1926, p. 164.

A Stellar System 700,000 Light Years Away. *Sci. Am.*, Apr. 1926, p. 229.

ATOMS

Atomic Time. *Lit. Dig.*, Feb. 20, p. 24.

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AVIATION

- Americans Plan the World's Largest Airship. Pop. Sci. Mo., May, 1926, p. 34.
Making History in the Art of Aeronautics. Pop. Sci. Mo., May, 1926, p. 50.
Learning to Use Our Wings. Sci. Am., Feb. 1926, p. 120; April, 1926, p. 262.

BIOLOGY

- What Burbank Plans to Do in the Next Five Years. Pop. Sci. Mo., Apr. 1926, p. 11.
What Is Life? Sci. Am., Feb. 1926, p. 81.

BIRDS

- The Carolina Wren. Sci. Am., Mar. 1926, p. 178.

CAPILLARY ACTION

- Methods of Testing the Absorption of Water by Cotton Toweling. Jour. Home Econ., Apr. 1926, p. 193.

CLEANING

- Poisonous Cleaning Fluids. Lit. Dig., Feb. 27, 1926, p. 24.

COLLOIDS

- *Colloids in Industry. Jour. Chem. Educ., Mar. 1926, p. 324.

COMMUNICATION

- Telephoning Beneath the Sea. Sci. Am., Mar. 1926, p. 170.
How Photos Are Cabled Across the Atlantic. Sci. and Inv., Apr. 1926, p. 1087.

CONSTRUCTION

- Tests You Should Make Before Buying Your House. Pop. Sci. Mo., Apr. 1926, p. 29.
More Mud Houses. Sci. Am., Mar. 1926, p. 174.

COSMIC RAYS

- Cosmic Rays. Sci. Am., Mar. 1926, p. 149.

DIAMONDS

- The Art of Cutting Diamonds. Sci. Am., Mar. 1926, p. 176.

DIVING

- A Deep Sea Diving Suit to Reach Sunken Submarines. Sci. Am., Feb. 1926, p. 116.

DYEING

- Common Salt in the Dyehouse. Dyestuffs, Feb. 1926, p. 23.

EARTHQUAKES

- Can We Predict Earthquakes? Sch. Sci. and Math., Apr. 1926, p. 420.

ELECTRICITY

- A Tree of Electricity (chart). Sci. Am., Mar. 1926, p. 171.

ELECTROLYSIS

- The Restoration of Ancient Bronzes. Sci. Am., Mar. 1926, p. 172.

ENGINEERING

- An Epoch-making Engineering Achievement; The Laying of High Voltage Submarine Power Cables Across the Mississippi. Sci. Am., Feb. 1926, p. 100.
Our Alaskan Railroad. Sci. Am., Mar. 1926, p. 151.
The Six-Mile Moffat Tunnel. Sci. Am., Apr. 1926, p. 244.
Diving Through Mud to Rock. Sci. Am., Apr. 1926, p. 236.

ETHER

- *The Ether-drift Experiments of 1925 at Mount Wilson. Sci. Mo., Apr. 1926, p. 352.

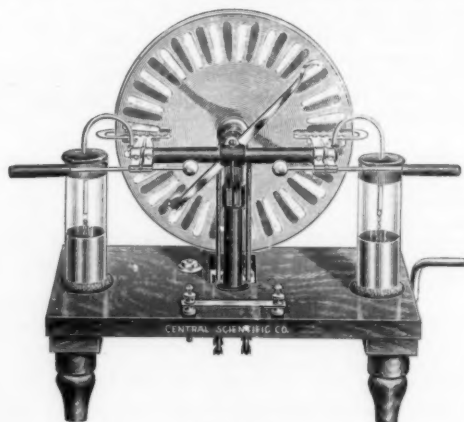
FERTILIZER

- *The Fixation of Atmospheric Nitrogen. Jour. Chem. Educ., Feb. 1926, p. 170.

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FORESTRY

Seeding California Redwoods for Future Forests. Lit. Dig., Feb. 27, 1926, p. 21.

Uncle Sam, Spendthrift. Sci. Am., Apr. 1926, p. 230.

FUEL

The Story of Coal (pictures). Sci. and Inv., Apr. 1926, p. 1097.

*GOODYEAR, CHARLES—See "Rubber."

*HEALTH AND HYGIENE

The Man-Eating Microbe. Hygeia, Apr. 1926, p. 187.

The Rat Menace. Hygeia, Apr. 1926, p. 206.

The Trial of Jimmy Germ (playlet). Hygeia, Apr. 1926, p. 228.

Measles Control Near at Hand. Lit. Dig., Mar. 21, 1926, p. 21.

All-Day Suckers. Hygeia, Mar. 1926, p. 145.

HUMIDITY

Cooling Your House in Summer. Sci. Am., Mar. 1926, p. 160.

INDUSTRY

Co-operation between Industry and University. Sci. Mo., April, 1926, p. 281.

The Frontiers of Industry. Sci. Mo., April, 1926, p. 285.

Research the Prime Mover of Industry. Sci. Mo., April, 1926, p. 289.

(N. B.—These articles give a good deal of information about the history of the development of various industries.)

INSECTS

Hungry Moths Cost Us Millions. Pop. Sci. Mo., May, 1926, p. 33.

The Useful White Ant. Lit. Dig., Feb. 20, 1926, p. 27.

METEORITES—See "Astronomy."

METRIC SYSTEM

The Metric System and Mr. Dale. Jour. Chem. Educ., Feb. 1926, p. 216.

MILLIKAN—See "Cosmic Rays."

MOLDS

Marvels of Mycetozoa. Nat. Geog., Apr. 1926, p. 421.

POISON GAS

Peace Time Use for "Poison Gas." Sci. Am., Mar. 1926, p. 118.

RADIO

(Because of the many magazines devoted to Radio alone, and the extensive departments devoted to this subject in most scientific magazines, radio articles are too numerous to list separately.)

REPRODUCTION

*Sexual Reproduction in Water Silk.

RUBBER

He Pawned His Umbrella to Give Us Rubber. Pop. Sci. Mo., Apr. 1926, p. 17.

*The Chemistry of Rubber. Jour. Chem. Educ., Mar. 1926, p. 253.

RUST

\$300,000,000 Annually Consumed by Rust. Sci. Am., Apr. 1926, p. 240.

SAFETY TEACHING—See "Cleaning."

STAR—See "Astronomy."

STEEL

New Steel Resists Great Heat. Sci. and Inv., Apr. 1926, p. 1091.

SUN—See "Astronomy."

SUBMARINES

Safety on Submarines. Sci. and Inv., Apr. 1926, p. 1083.

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TEXTILES

The Persian Lamb and Our Fur Industry. Sci. Am., Apr. 1926, p. 246.

Photography in the Textile Industry. Photo-Era Mag., Apr. 1926, p. 204.

See also "Capillary Action" and "Wool."

TRANSMUTATION OF ELEMENTS

The Transmutation of Elements. Sci. Am., Feb. 1926, p. 80.

VENTILATION—See "Humidity."

WATER POWER

The Subjugation of the Colorado. Sci. Am., Mar. 1926, p. 159.

WEATHER

Ice Flowers. Sci. Am., Feb. 1926, p. 106.

To Change South Africa's Climate. Lit. Dig., Feb. 27, 1926, p. 23.

The Mythological Rain Tree. Sci. Am., Apr. 1926, p. 251.

WOOL

Artificial Wool Next. Lit. Dig., Feb. 27, 1926, p. 22.

PROFESSIONAL

The Problem of Science Teaching in the Secondary Schools—A Comment. Sch. Sci. and Math., Mar. 1926, p. 301.

Teaching the History of Chemistry. Journ. of Chem. Educ., Feb. 1926, p. 166.

Science and Modern Humanism. Sch. Sci. Rev., Feb. 1926, p. 145.

A Study of Science Articles in Magazines. Sch. Sci. and Math., Apr. 1926, p. 389.

The Training of Science Teachers. Sch. Sci. and Math., Apr. 1926, p. 402.

Magazine List

American City. 443 Fourth Ave., New York City. Monthly. \$4.00 a year, 50c a copy. The science problems of city and rural communities are treated in numerous articles, well illustrated. A valuable student and teacher reference.

The American Food Journal. 25 East 26th Street, New York City. Monthly. \$3.00 a year, 25c a copy. Articles on food manufacture, food legislation, and experiments in nutrition.

Commercial America. Philadelphia Commercial Museum, Philadelphia, Pa. \$2.00 a year. Ill. Commercial production. New inventions. Will interest commercial geography and science teachers.

Current Opinion. 65 West 36th St., New York City. Monthly. 35c a copy, \$4.00 a year. Has a regular department, "Science and Discovery," containing articles of popular interest, adapted to pupils or teachers.

The Educational Screen. 5 South Wabash Ave., Chicago. Monthly. 20c a copy, \$1.50 a year, with "One Thousand and One Films," \$1.75 a year. Discusses the use of motion pictures in our schools; gives brief descriptions of educational films and lists theatrical films which are suitable for children. The journal is entirely educational, having no commercial affiliations.

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The Geographical Review. Broadway at 156th St., New York. Quarterly. \$1.25 a copy, \$5.00 a year. Devoted to scientific geography. Original maps and pictures. One department contains condensed items of topics of current interest.

The Guide to Nature. Sound Beach, Conn. Monthly. 15c a copy, \$1.50 a year. Ill. Of interest to elementary pupils and teachers of nature study.

Hygeia. 535 North Dearborn St., Chicago. Monthly. 25c a copy, \$3.00 a year. Popular articles on individual and community health. A valuable supplement to classroom work in hygiene.

Industrial and Engineering Chemistry. Box 505, Washington, D. C. Monthly. 75c a copy, \$7.50 a year. A technical journal which contains much material which teachers can use.

Industrial Education Magazine. Peoria, Illinois. Monthly. \$1.50 a year, 25c a copy. An illustrated magazine, which is indispensable to the shop instructor and to others who would "keep up"

Journal of Chemical Education. Easton, Pa. Monthly. \$2.00 a year. Promotes chemical education; primarily a journal for the chemistry teacher. Digests of activities of chemical associations.

Journal of the Franklin Institute. Philadelphia, Pa. Monthly. 50c a copy, \$6.00 a year. Ill. A technical journal. Contains many articles of value to science teachers.

Journal of Home Economics. 617 Mills Bldg., 700 17th Street N. W., Washington, D. C. Monthly. 25c a copy, \$2.50 a year. For teachers.

The Literary Digest. 354 Fourth Ave., New York. Weekly. 10c a copy, \$4.00 a year. Has a department, "Science and Invention." Articles are mostly digests from other journals. They are popular in nature and suitable for high school pupils.

National Geographic Magazine. Washington, D. C. Monthly. 50c a copy, \$3.50 a year. Best monthly journal for high-grade pictures. Articles are of interest to general reader, pupils and teachers, as well as to geographers.

The Nation's Health. 22 East Ontario St., Chicago, Ill. Monthly. \$3.00 a year, 25c a copy. An illustrated magazine devoted to community, industrial and institutional health problems. Very helpful to the science and hygiene teacher.

Nature Magazine. 1214 Sixteenth St., Washington, D. C. Monthly. 25c a copy, \$2.00 a year. A nature magazine, with popular articles exceptionally well illustrated. Includes what was formerly "Nature Study Review."

Popular Mechanics Magazine. Chicago. Monthly. 25c a copy, \$3.00 a year. Short science items and articles, well illustrated. Appeals strongly to elementary pupils. Suggests many construction problems.

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Civic Science in Home and Community . . . \$1.60

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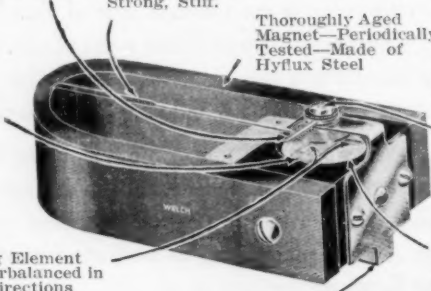
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Ammeter, Direct Current, with double scale, No.	2757S	2757S
Range, zero to, amperes	15 and	1.5
Smallest division, amperes	0.1 and	0.01
Each		\$18.00
Lots of 3, each		\$16.00
Voltmeter, Direct Current, No.	2758A 2758B 2758D	2758L
Range, zero to, volts	15 150 250	1.5
Smallest division, volts	0.1 1.0 2.0	0.1
Each	\$16.00 \$16.00 \$18.00	\$20.00
Lots of 3, each	\$14.50 \$14.50 \$16.00	\$18.00
Voltmeter, Direct Current, with double scale, No.	2758T	2758C
Range, zero to, volts	15—1.5	150—15
Number of scale lines	150	150
Each	\$22.00	\$18.00
Lots of 3, each	\$20.00	\$16.00
Volt-Ammeter, Direct Current, combined instrument, No.	2757	
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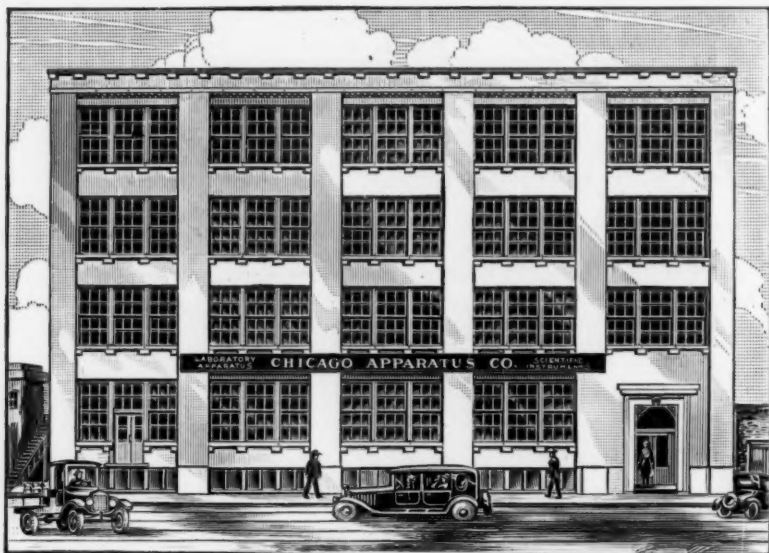
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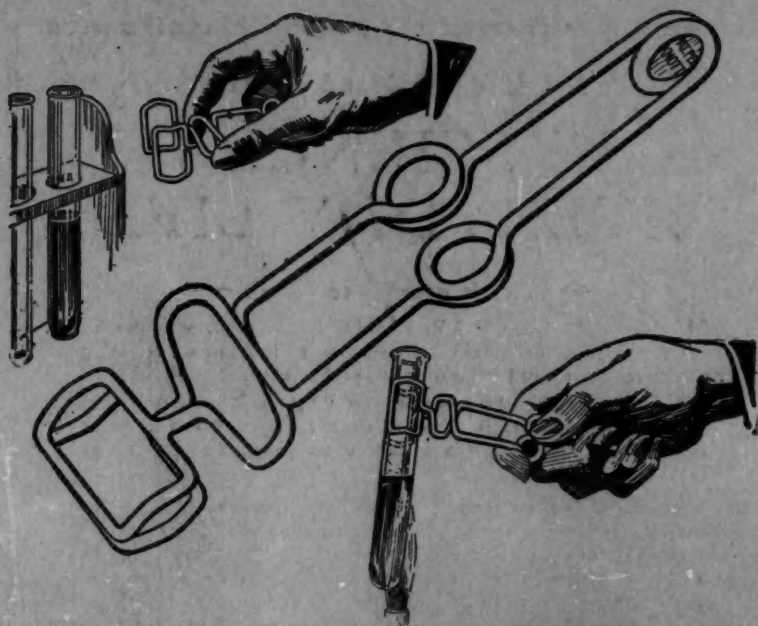
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